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1900-01



# Public School Report

1900-1901



Oakland, California



# ANNUAL REPORT

—OF THE—

# PUBLIC SCHOOLS

—OF THE—

CITY OF OAKLAND

FOR THE YEAR ENDING JUNE 30th, 1901

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PUBLISHED BY ORDER OF THE

BOARD OF EDUCATION

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OAKLAND:  
R. S. KITCHENER Co., 565 THIRTEENTH ST.  
1901.



## CALENDAR.

For the Year Ending June 30, 1902.

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*Regular meetings of the Board of Education to be held on the first and third Monday of each month, as follows :*

1901	1902
July 1st and 15th	January 6th and 20th
August 5th and 19th	February 3rd and 17th
September 2nd and 16th	March 3rd and 17th
October 7th and 21st	April 7th and 21st
November 4th and 18th	May 5th and 19th
December 2nd and 16th	June 2nd and 16th

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Fiscal Year begins July 1, 1901.

First Term begins Monday, July 29, 1901.

First Term ends Friday, December 20, 1901.

Second Term begins Monday, January 6, 1902.

Second Term ends Friday, June 6, 1902.

### VACATIONS.

Two weeks, beginning Monday, Dec. 23, 1901.

One week, beginning Monday, March 24, 1902.

Seven weeks, beginning Monday, June 9, 1902.

**BOARD OF EDUCATION.**

**OF OAKLAND, CAL.**

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**1901-1902.**

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C. H. Redington, <i>President</i>	- - -	1668 Seward St.
John W. McClymonds, <i>Supt. and Sec.</i>	-	447 34th St.
R. B. S. York, <i>Asst. Supt. and Sec.</i>	-	489 34th St.
Fred. L. Button	- - - -	568 34th St.
Frederick C. Clift	- Walsworth, cor.	Bayo Vista Ave.
John W. Evans	- - - -	304 E. 14th St.
Giles H. Gray	- - - -	754 10th St.
John D. Isaacs	- - - -	1154 Alice St.
Myra W. Knox	- - - -	958 14th St.
Geo. E. Randolph	- - - -	672 18th St.
D. Robertson	- - - -	1814 Atlantic St.
John Russ	- - - -	543 Albion St.
Wilbur J. Wilcox	- - - -	576 E. 14th St.

*To the Honorable, the Board of Education,  
of the City of Oakland, California :*

I have the honor to present my report as City Superintendent of Schools, and Secretary of the Board of Education, for the year ending June 30th, 1901.

Last year an elaborate report of the condition of our schools was issued. I will therefore confine myself in this report to a very brief statement in reference to matters pertaining to our schools.

I desire publicly, at the opening of this report, to express to the principals and teachers of this department my sincere thanks for the cordial support I have received from them in my efforts to raise the schools of Oakland to a higher standard of efficiency than they have yet reached.

The Nature Study of the department has been successfully carried on this year, and I desire here to present for your consideration the course of Study as outlined by the director of that branch of education :

## NATURE STUDY.

OAKLAND, June, 1901.

*J. W. McClymonds,  
Superintendent of Public Schools.*

*Dear Sir:*

The following report will include a few of the changes suggested by the past year's work in Nature Study. The course of study has been slightly reorganized with the idea of carrying throughout the course a developing line of work from which other subjects naturally arise, thus allowing the greatest possible freedom with an underlying thread that binds the scattered fragments into the ultimately developed whole.

Feeling the need of a change of work in the Eighth Grade, Junior Science Clubs have been formed in the Eighth Grade of all schools where classes were large enough to do satisfactory work. The object of these clubs is to bring the children to feel responsible for the work. They organize having as officers a President, Secretary and Curator. The rules regulating the clubs are as follows: All boys and girls of Eighth Grade are eligible for membership. Meetings shall be arranged for at convenience of the class. These shall be as often as once a month. Once each month the clubs of Oakland shall come together for a joint meeting, where a speaker shall be provided. The dues of

the Club shall be a monthly donation of some specimen, written or oral statement of some work, preferably original observations, made to the class collection. These shall be in the charge of the Club Curator. Each month the Curator shall loan a collection, written observations or other specimens of work done, to the headquarters in the High School Building. Many clubs work in sections, and some excellent work has been done. Special mention should be made of the Electrical Section in the Eighth Grade of the Cole School.

Outing sections are being formed, to begin work this year. The hope is that this work will stimulate individuality and independence.

Suggestions are made in the course of study for such grades as work together and are interested in this subject.

All other changes have been made with an attempt at better adjustment to age, and in view of more complete correlation with other work.

The supplies of this department are to be kept in the office of the Supervisor, and are to be sent to the teachers only when blanks, which are provided for this purpose, shall have been properly filled out and sent to this office. Teachers shall be responsible for the return of such material in good condition.

Each teacher shall send to the office of her Principal Friday of each week a card (which shall be provided for this purpose) with a brief statement of the Nature work done in her class during that week. Principals shall send these cards to the City Superintendent's office Monday of each week.

Teachers are urged to take their classes into the country for observation of animals and plants under normal conditions. These excursions should be carefully planned for, and arrangements may be made by notifying the Supervisor a few days before the outing.

A few leaflets are here presented. These leaflets are largely compilations gathered from various sources for the help of the teacher. She must have a well defined plan of her work in mind before she can do anything with her children. The children must not be conscious of this plan, however, as they set about the work. The elaborate outlines and systematically arranged course of work is only for the teacher. These outlines are offered as suggestions merely; any additions or corrections will be earnestly welcomed.

The leaflets on "Moon" and "Care of Aquaria" represent work done in the Alameda schools, under the direction of Miss Helen Swett. Leaflets on "Trees" and "Birds" are combinations of the work done in the Alameda and the Oakland schools during the past year.

### **COURSE OF STUDY**

The work in the First and Second Grades is not to be detailed work. Each teacher should have in the room a breeding cage, an aquarium, a seed box and boxes of earth. These are to be kept well

stocked during the year and the children given time to observe the life. The directions given the children shall be only such as to develop their observation; to depend on the senses and not upon reasoning. The work for the grades is put together in this course of study that the teachers may understand that no haste is expected and all work is to be carried on through the entire year.

### **Prescribed Work For the First and Second Grades**

**SEEDS, GROWTH.** (1st Outline, p. 4, 2nd Outline, p. 16.)

Germination of seeds.

Parts of the seeds.

What is necessary to make the seed grow.

How the plant breaks out of the seed.

How the plant comes out of the ground.

The roots of the plant as they seek food.

The leaves of the plant as they seek food.

The growth of roots from cuttings.

Air roots.

In fact all phenomena of the growing plant that can be made out by the children.

**SEEDS.** (2nd Outline of Nature Study, Dr. Jenkins, p. 16.)

Observations with reference to form, arrangement in the seed case and method of distribution. Collection of seeds to show their method of distribution.

**MOTHS, BUTTERFLIES, CATERPILLARS.** (2nd Outline, p. 31.)

Breeding cages and food.

Egg, size and growth.

Growth of caterpillars, their feeding and moulting.

Cocoons or chrysalides, how made and of what.

Butterfly or moth; life and habits.

**DEVELOPMENT OF FROGS AND SALAMANDERS FROM THE EGG,  
WITH COMPARISON.**

**STUDY OF DOMESTIC ANIMALS THE CHILDREN MAY HAVE AS PETS:**  
cat, dog, rabbit, etc.

### **Optional**

Select any two subjects from the Selected List.

One subject selected by the teacher from any outside source.

### **Prescribed Work for Third Grade.**

#### **WAY PLANTS SPREAD.**

- Roots.**
- Bulbs.**
- Runners.**
- Branches bending and rooting.**
- Water transportation of plants.**

#### **SEED DISTRIBUTION.**

- Water transportation of seeds.**
  - Cork buoys.**
  - Air-tight sack buoys.**
  - Wings and sails, etc.**
- Wind transportation of seeds.**
  - Tumble weeds.**
  - Light pods.**
  - Bristles and hairs.**
  - Tufts or parachutes.**
  - Wings, etc.**
- Shooting seeds.**
- Twisting seeds.**
- Burs.**
- Carried by animals and man.**

#### **PLANT PROTECTION.**

- Spine, hair, juices, etc.**

#### **COVERING OF ANIMALS. (1st Outline, p. 20, middle of page.)**

#### **BUDS.**

#### **ANIMAL PROTECTION, DEFENSE, ATTACK.**

- Flight (horse, deer, mouse, rabbit, fish, snake).**
- Teeth (cat, dog, squirrel, *et al*).**
- Claws (cat, tiger).**
- Kicking (horse, mule, deer).**
- Tossing and goring (cow, goat, deer).**
- Pecking (hen, all birds).**
- Dodging (squirrel, mouse).**
- Color and markings (toad, caterpillar, snake).**
- Mimicry (fox, insects).**
- Nipping (clam, lobster, crab.)**

Spines (hedgehog, caterpillars).

Ejecting fluids (skunk, squid, insect).

During seed growing time, plant seeds not before studied, such as sun flowers, castor oil bean, buckeye, walnut, peach or any other brought in by the pupils for their study. Use the directions given under the same subject for the First Grade. In connection give the experiments under "The Plant's Food" (1st Outline, p. 18).

### Optional

Select any two subjects from the Selected List.

Select one subject from any outside source.

### Prescribed Work for the Fourth Grade

PLANT MOVEMENT (clover, oxalis, *et al.*).

LIGHT RELATIONS.

CLIMBING PLANTS.

1. Plants which twine spirally around a support.
2. Plants which climb by means of tendrils, etc.
3. Plants which climb by means of hooks.
4. Plants which climb by means of rootlets.

STUDY OF THE WORK OF BROOKS, the animal and plant life in and about the brooks. Use this work as illustrating the distribution of plants and animals in California, and show their dependence upon temperature, moisture, soil and food for work in Geography.

STUDY SURFACE FILM OF WATER BY EXPERIMENT.

POND LIFE. (1st Outline, p. 15; Western Journal of Education, July, 1899, p. 14; II, p. 23).

The green scum of ponds.

Diatoms.

AQUATIC INSECTS.

Dragon flies.

Water beetles.

Caddis worms.

Pond skaters, or water striders.

Water boatmen.

Whirligig beetles.

DEVELOPMENT OF THE MOSQUITO FROM THE EGG TO THE ADULT.  
(Western Journal of Education, Nov., 1898, p. 9.)

Begin weather observations to assist observations on temperature, winds, clouds, seasons, altitude, etc., in their relation to the climate of California in connection with Geography.

**SOLUTION.** (1st Outline, p. 10.)

Solution of various common substances that will readily dissolve in water, such as salt. Those that will not dissolve readily, as camphor, potassium bichromate, copper sulphate, and the like. Those that do not dissolve perceptibly, such as whiting, starch, etc.

**EVAPORATION OF VARIOUS LIQUIDS, SUCH AS WATER, ALCOHOL, GASOLINE.** (See Outline, I, p. 8.)

Compared with glycerine. Prove existence of vapor by use of either, alcohol, chloroform.

Show that heat is used up during evaporation.

Evaporation of solids, such as camphor and iodine.

Condensation.

Show sources of vapor of water by condensation from breath, surface of skin, under surface of leaf, etc.

Distill water from a flask.

Evaporation of water to regain substance, showing crystals.

**CRYSTALS.** (1st Outline, p. 18.)

**FROST AND ICE.** (2nd Outline, p. 28.)

Formation of frost.

Temperature melting ice.

Temperature freezing mixtures.

Why ice floats.

Manufacture of artificial ice.

Application to geographical features.

Use of funnel and filter paper to show dissolved substances.

Application of these phenomena to frogs, clouds, snow, rain, formation of soils, erosion, etc.

#### **Optional**

Select any two subjects from Selected List for Grades.

Select one subject from any outside source.

#### **Prescribed Work for the Fifth Grade**

**GROWTH OF PISTIL TO THE FRUIT IN DANDELION, BURR CLOVER, GERANIUM, POPPY, SWEET PEA.** At least any other five may be substituted for these at the convenience of the teacher. (1st Outline, p. 36, par. 2, 3, 4, 5.)

**FRUITS.** (2nd Outline for Nature Study, p. 17.)

Use of edible parts.

Change in fruit by cultivation and selection.

Structure of the fruit—its parts, their arrangement in reference to each other.

How green fruit becomes ripe.

Digestion of starch in human body.

Use of sugar in plant life; in animal life.

Gardening in the school yard where possible, otherwise the children shall be encouraged to do the work at home.

A careful study of the insects and other animals met with in connection with this work shall be part of the regular work.

**EARTHWORM, SNAIL, SLUG, INSECTS, TOAD, GOPHER, etc.**

All possible experiments with growing plants shall be a part of this work.

Growth and use of root hairs. (1st Outline, p. 11.)

The plant's food.

Show that plants take up water. (1st Outline, p. 28).

Show that water escapes from plant's leaves. (1st Outline, p. 29).

(Examination of stomata. (1st Outline, p. 29.)

Material of soil dissolved in water and used by plants. (1st Outline, p. 29.)

Making, using and storing starch in the plant.

**CAPILLARY ATTRACTION.** (2nd Outline, p. 28.)

Illustration of capillary attraction by means of a set of tubes, sheets of glass, a sponge, cloth, lump of sugar, etc.

Capillary attraction in gravel, sand, clay.

Application to plant life in California.

Reason for cultivation of orchards.

**SOILS.** (2nd Outline, p. 27.)

Structure.

Kinds of soil.

Relation of soil to growing roots.

Relation of soil to percolating water.

The observation of weather should be continued from the Fourth Grade.

**Prescribed Work for the Sixth Grade**

The work of this grade shall continue the work of the Fifth Grade.

Gardening and out-door observations on the relations between plants and animals shall form the greater part of the work. Wild flowers shall be collected, pressed or painted and studied.

**FLOWERING PLANTS.** (1st Outline, p. 24; 2nd, p. 30. Western Journal of Education, May, 1899, p. 15.)

Work of the flower.

Parts of the flower seen in as many forms as possible.

- 1st. Place of minute beginnings of seeds in ovary.
- 2nd. Extension into style and stigma.
- 3rd. Stamens with pollen.
- 4th. Corolla.
- 5th. Calyx.

Provisions for fertilization as seen in lupine, locust tree, peas, beans, cloves, or any plant of the Leguminosæ.

Use of corolla, calyx, honey, perfume, color, etc., to the plant.

Provisions for fertilization as seen in petunia, morning glory and the like.

Provisions for fertilization as seen in grasses, wheat, corn, rye, oats, etc.

Provisions for fertilization as seen in conifers.

Provisions for fertilization as seen in the melon family.

**A CAREFUL STUDY OF BEES AND BUTTERFLIES** shall be made in connection with the work on flowers.

**BUTTERFLIES.**

Keeping of caterpillars.

Collecting and care of butterflies.

Feeding habits and life habits in general.

Familiarity with larger groups of butterflies.

Experiments to test strength, etc.

**METALS.** (1st Outline, p. 27.)

Collection of pure metals, such as copper, lead, zinc, iron, aluminum, platinum, etc.

Properties, as relative harness, flexibility, ease of welding, etc.

Alloys.

Uses.

How metals are taken from their ores.

Application to mining.

**LEAD PENCILS.**

Structure and materials.

**GRAPHITE.**

Properties, uses and comparison with common metals. (2nd Outline, p. 19.)

**HEAT.**

Sources.

Conduction.

**EFFECTS OF HEAT ON LIQUIDS, GASES AND SOLIDS WITH THE  
STRUCTURE AND USE OF THE THERMOMETER.** (1st Outline Nature Study, p. 5.)

**Prescribed Work for the Seventh Grade**

This class shall work throughout the year on trees.

Familiarity with the general appearance of common trees and their dependence upon environment, study of leaf, flower, fruit, bark, wood, and the economic value of any part.

This work shall be done in connection with drawing as far as possible, also encourage use of camera.

Keep carefully pressed specimens of every tree studied.

Carry along with this work the study of the tree visitors.

**BIRDS.**

Observations of life habits; familiarity with common forms of California birds.

**GALLS.**

Study of gall flies and their homes.

**SPIDERS.** (2nd Outline, p. 33).

Collection and care of living spiders in jars in schoolrooms.

Food.

Web. What kind of a spider made it, how did it weave it, what use is made of it?

Spinning organs. Position. Structure. How used.

General appearance of spiders.

Different families of spiders with characteristic cs.

**OXYGEN AND CARBONIC ACID.** (1st Outline, pp. 21-23.)

Preparation.

Properties.

Uses.

Application to human life, plant life, etc.

**DIFFUSION OF GASES.** (1st Outline, p. 23.)

**STUDY OF THE CANDLE FLAME.** (1st Outline, p. 26).

Parts of the flame.

How the flame is produced.

Use of different materials for producing flame.

**ILLUMINATING GAS.**

Preparation of gas in school room.

Process of burning in coal and wood.

Preparation of gas for use in city.

Visit to gas works.

**Prescribed Work for the Eighth Grade.**

**PLANT SOCIETIES.** (Working syllabus.)

**I. Struggle for existence.**

**a. Factors in the struggle.**

**1. Water.**

a. Temporary periods of drought.

b. Permanent drought.

1. Natural agencies.

a. Formation of new soil.

2. Artificial agencies.

a. Drainage.

b. Forest destruction.

**2. Light.**

a. Plant strata.

b. Forests.

1. Open.

2. Deciduous.

3. Evergreen.

**3. Changes in temperature.**

a. Geological.

b. Altitudinal.

c. Annual.

**4. Wind.**

**5. Changes in soil composition.**

a. Kinds of soil.

1. Rock.

2. Sand.

3. Lime.

4. Clay.

5. Humus.

6. Salt.

- b. Soil cover.
  - 1. Leaves.
  - 2. Plants.
  - 3. Snow.
- c. Natural agencies.
  - 1. Geological changes.
  - 2. Flood changes.
  - 3. Shifting dunes.
- d. Artificial agencies.
  - 1. Clearing.
  - 2. Draining.
  - 3. Fertilizing.
- 6. Devastating animals.
  - 1. Grazing animals (sheep, cattle, *et. al*).
  - 2. Seed eating birds.
  - 3. Burrowing animals (gopher, *et. al*).
  - 4. Rooting animals (hog).
  - 5. Leaf eating insects.
  - 6. Wood boring insects.
  - 7. Scale insects.
  - 8. Snails.
- a. Means of protection (thorns, spines, stinging hairs, cutting edges, nauseating, bitter or poisonous juices, *et al*).
- 7. Plant rivalry.

## II. Forms of plant societies.

- A. Hydrophyte societies.
  - 1. General characters.
  - 2. Adaptations.
    - a. Thin-walled epidermis.
    - b. Roots much reduced or wanting.
    - c. Reduction of water-conducting tissues.
    - d. Development of air cavities.
      - 1. Aerate the plant.
      - 2. Increase buoyancy.
  - 3. Free swimming societies.
    - a. Submerged.
      - 1. Diatoms.
    - b. Floating.
      - 1. Duckweed *et al*.
  - 4. Pond weed societies.
    - a. Rock societies (Algae).
    - b. Loose soil societies.

5. Swamp societies.
  - a. Reed swamp.
  - b. Swamp-moor.
  - c. Swamp thicket.
  - d. Sphagnum-moor.

B. Xerophyte societies.

1. Problems to meet.
  - a. Possible drought.
  - b. Periodic drought.
  - c. Perennial drought.
2. Methods.
  - a. Collection and retention of water.
  - b. Prevention of loss of water.
3. Adaptation.
  - a. Complete desiccation.
  - b. Periodic reduction of surface.
  - c. Temporary reduction of surface.
  - d. Fixed light position.
  - e. Motile leaves.
  - f. Reduced leaves.
  - g. Hairy coverings.
  - h. Body habit.
  - i. Anatomical.
  - j. Water reservoirs.
4. Societies.
  - a. Rock.
  - b. Sand.
    1. Beach.
    2. Dune.
    3. Sandy fields.
  - c. Thickets.
  - d. Forests.
    1. Corriferous.
    2. Foliage.
    3. Leafless.

C. Mesophyte societies.

1. General characters.
2. Grass and herb societies.
  - a. Artic and Alpine carpets.
  - b. Meadows.
  - c. Pastures.
3. Woody societies.
  - a. Thickets.
  - b. Deciduous forests.
  - c. Foliage forests.

D. Halophyte societies.

1. General characters.

2. Arias.

- a. Seashore, salt lake, salt springs, interior arid wastes.

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Bergen	Elements of botany.	p. 196.
Coulter, John	Plant relations.	p. 142.
Macdougall	Nature and work of plants.	p. 191.
MacMillan	Minn. Bot. studies, Bul. 9, pts. 10 and 11.	
Marsh	The earth as modified by human action.	
Warming	Ökologischen Pflanzen-geographie.	
Cornell	Nature Study Quarterly, No. 6, Oct., 1900.	

PRESSURE OF LIQUIDS AND AIR. (1st Outline, p. 17.)

Why bodies float.

Why some bodies float more above the water than others.

Why some bodies sink.

Effect of some floating bodies in lighter or heavier liquids.

Application to ventilation and winds.

Construction and use of barometer.

CURRENTS IN WATER. (1st Outline, p. 19.)

Currents in boiling water.

Currents in vessels of different shapes.

Effect of unequal heating on currents.

Application to ocean currents.

CURRENTS IN AIR. (1st Outline, p. 20.)

Exploration of school room for currents of air.

Construction of hot-air balloon.

Application to winds and to ventilation.

To be done in connection with Geography work.

All EXPERIMENTAL work done in connection with the Physical Geography work for this grade.

Selected List for Grades.

Buds.

Ants. Life history and habits studied from a nest in the room as well as by outside observation.

Crabs, shrimps, lobsters and clams.

Earthworms.

Coverings of animals.

Snails and slugs.

Common minerals.

Lead pencil.

Fish in an aquarium.

Spiders.

Ferns, mosses.

Meteorology. (Keeping of simple daily observation on weather.)

Germination and growth of seeds.

Magnet, its properties and uses.

Distribution of seeds.

Moths, butterflies and caterpillars.

Development of frogs and salamander's eggs.

Development of mosquitoes.

Bees and wasps.

Pond life including aquatic insects.

Coverings of animals.

Fruits.

Effects of heat on gases, liquids and solids, or any of the physics experiments.

Flowering plants.

Oxygen.

Carbonic acid.

**THE FUNGI GROUP**, including mushrooms and the like, puffballs, geasters, moulds, lichens; also examples of parasitic plants, such as mistletoe and dodder, their life history, place of growth, spore surfaces, discharge of spores, etc. Collect as many varieties as possible. Compare the various forms studied. (1st Outline, p. 10.)

**MARINE LIFE**. Crabs and shrimps (or lobster). (2nd Outline, p. 20.)

Observation of motions, by what parts and how accomplished.

Study of appendages, attachment to body; the joints, their forms and uses. Study of body, its divisions and the joints which make it up. Comparison of the two. Comparison with some insect already studied.

**PENDULUM**. (1st Outline, p. 28.)

Construction.

Length of a pendulum that vibrates once in one minute.

Pendulums with same length but different weights.

Construction of pendulum that vibrates once in two seconds.

Construction of pendulum that vibrates twice in one second.

Construction of pendulum that vibrates once in three seconds.

Construction of pendulum that vibrates three times in one second.

Use of pendulum as a time instrument.

#### LIFE HISTORY OF FERNS.

Parasitic plants, mistletoe, dodder, etc.  
Surface film of water.  
Birds.  
Soap bubbles.  
Moon.  
Galls.  
Life history of house fly.  
Life history of lady-bug or other beetle.  
Life history of silk worm.

#### REPTILES.

Lizard, snake, horned toads, turtles.  
Leaf-cutter bees. (Outline II, 31.)

### TREES

Trees furnish a subject rather for continuous work throughout the year than for any one short series of lessons. Observations of seasonal changes are always in order and will serve to keep alive the interest awakened in the children at the beginning. These observations would be most fruitful if followed up by drawing and photography, however crude.

GENERAL REMARKS.—The first aspect to be presented is that of the relation of the tree to its environment. Points in plant physiology and structure come up in the foregoing study, but, however necessary, are subsidiary. Selected facts are given below for the convenience of the teacher, and reading references are appended which will give access to a wider range of facts. The lessons should not be too technical, but should have for the prevailing motive the instilling of a love for nature. The preparation of the teacher, therefore, must be along two lines, technical and non-technical. An outline should be made indicating in general what points are to be taken up at what seasons, what material will be needed for the establishing of each point, and how this can best be provided. Some things are only to be made clear by out-door observation. Plan for this by going over the ground in advance, and before taking a class out let them understand clearly, not what they are to *see*, but what they are to look for.

THE TREE'S LIFE RELATIONS.—Relation to *wind*. Trees may yield, as weeping willow, eucalyptus; or resist, as oak. Trees of the former type are seldom permanently distorted, but those of the latter often suffer from the blighting of buds on the wind-swept side, and so grow away from the wind. Examples: Most live oaks along the bay shore, and along the crest of neighboring hills; cypresses of Monterey

bay (pictures of these may be shown to the children). *Rain*.—As it will not do for leaves to become wet with rain, their position, structure and character of upper surface usually favor the prompt shedding of water which falls upon them. In some trees (and herbs) the water is led to the main stalk of the plant and runs down it to the roots. The cracks in the bark of certain trees act as troughs to guide the water to the roots. In some trees the water dips from every part, as the eucalyptus; in others it is shed as from the eaves of a house, or from the roof of a tent, as the pines; and in fact, most conifers. The latter mode is advantageous in a country of little rain, for the water is shed just above the circle of active root hairs. A definite relation between the root system and the shedding of water by the leaves is not to be looked for in the natives of marsh lands, for obvious reasons. *Light*.—Leaves are definitely related to light and air. The mode of branching of most trees is such as to expose leaves freely to the sun, while the position and shape of the leaf is such as to prevent, as far as possible, the shading of one leaf by another. But some trees cultivated here are natives of countries where light and heat are uncomfortably intense. Such trees avoid too much light and heat by presenting the *edge* of the leaf, as pepper tree, eucalyptus, acacia. The leaves of some plants are fixed in position; those of other plants have the power to adjust themselves to suit varying circumstances. The leaves of young mallow plants face east in the morning, west in the afternoon; oxalis, clover, the locust tree, have *day* and *night* positions; the sensitive plant closes its leaflets together under the influence of sudden heat. Positions of the leaf is not the only means of avoiding injury by too great exposure to light. Some leaves are protected by structure—thick skin, abundant hairs, etc., or color, e. g., the red of many young shoots (rose, apricot tree).

*Radiation and Evaporation*.—Plants of dry countries, where the days are hot and the nights cold, must guard against loss of heat and moisture. The sidewise presentation of the leaf, together with covering of felt-like hairs, breathing pores which can be closed, and sometimes a massing together of the leaves for mutual protection, are some of the ways of meeting this problem. Night positions of leaves are usually protective. Another way is the reduction of leaf surface—buckthorn (few leaves) and cactus (no leaves). The fuchsia is a plant which has no provision for closing its breathing pores; consequently it cannot be raised in the interior of California. On the first hot dry day of the season it wilt helplessly and never recovers. (For further discussion see references below, especially those to Coulter, Kerner and Oliver.)

**STRUCTURE OF TREE**.—It is the possession of a well-defined trunk, together with a height of thirty feet or more at maturity, which distinguishes a tree from a shrub, though no hard and fast line can be drawn. To be considered a tree a plant should always be long-lived. It is the business of the trunk to give support to the leaf-bearing

branches. It must also act as a means of communication between different parts of the tree. For this purpose there are associated with the woody fibres of the stem certain conducting tissues: open vessels, or ducts, for the passage of the crude sap up from the roots, and smaller, closed sieve tubes, which pass the elaborated sap from the leaf along the stem from cell to cell. Exogenous stems increase in thickness through the activity of the cambium layer just under the bark. In this layer the sap runs, and the diameter of the trunk and the thickness of the bark are increased at the same time. It is here that food not wanted for fruit or seed is stored up over winter for the use of the buds in the springtime (in deciduous trees). In some trees the outer layers of bark are shed each year, and the bark never becomes very thick—eucalyptus, sycamore, birch, madrone, manzanita. In others the bark must split as the trunk or branch widens—oaks, willows, redwoods, etc. The bark of rapidly growing cherry trees is often artificially split with a sharp knife. Cut a young stem across to see separate bundles of the conducting tissue mentioned above; saw an old branch off to identify successive rings of growth. If growth in the endogens were continuous and uniform throughout the year, there would be no rings. In spring and summer when moisture is abundant and the leaves are active, the cambium layer is active and growth rapid. Later in the season more mineral matter is deposited in the outer layers of cambium. As growth slows up, the cells are given thicker walls, and the wood is harder and finer grained in consequence, hence the rings by which the years of a felled tree are reckoned. To make out the path of ascending water in a stem, put the cut ends of several active twigs into red ink, and section at different points later. Young corn stems would furnish an interesting contrast to such stems as those of beans, etc., for the fibro-vascular bundles would be found distributed evenly throughout the stem. Such a stem (endogenous) increases in diameter, not by a thickening just under the bark, but by a uniform increase in diameter of all parts of the stem.

**LEAVES.**—The leaf is a lateral outgrowth of the stem. In lower plants it is hard to distinguish between leaf and stem. The leaf in higher plants is usually a much expanded organ, consisting of several layers of loosely packed cells containing green matter protected on each side by a skin. The veins are bundles of fibrous conducting tissue continuous with similar bundles in the twig. When a leaf is flattened and expanded horizontally, the breathing pores, or stomata, are most abundant on the under side. When, however, it assumes a vertical position, the two sides of the leaf are alike in color, texture and structure—iris, acacia, eucalyptus, *et al.* The upper angle between the leaf and stem is called the axil. Leaf-buds are usually axillary. Certain of the high plants have lost their leaves, *e. g.*, dodder and cactus. The former is a parasite, and does not have to make its own food; in the

latter the fleshy stems performs leaf functions. It is the business of the leaves to build up the rest of the plant; to make themselves and the trunk and branches longer and wider within certain limits; to develop buds, to furnish nutriment for the fruit and seed; and to store up in the cambium layer enough nutriment to give the buds a good start in the spring. It is the green part of the leaf which does all this work. Under the influence of light (direct sunlight is best), this chlorophyll, or "leaf-green" combines carbon dioxide of the air with water brought from the roots, into various complex substances, notably starch. Minerals from the soil form comparatively a very small part of the bulk of a tree, although some are important as helping to give solidity to the older portion of the tree, and others are indispensable to certain chemical processes. When wood is burned in the grate, the amount of ash left represents roughly the small proportion of matter furnished by the soil; the rest, which goes up in smoke, that which was derived mainly from air and water. Much of the water which served as a vehicle for the transportation of minerals from the roots to the leaf is allowed to evaporate from the leaf surface. This process is called transpiration. It is on this account that the shade of trees is cooler than the shade of a building, or of a tight board fence. The production of organized material, starch, etc., is called assimilation. The leaf has another function, which goes on day and night—that of respiration. As in animals, oxygen is taken in and carbon dioxide is given off, but the quantity of the latter gas which is thrown off is overshadowed during daylight hours by the much larger amount of oxygen given out in the process of manufacture of plant food.

**ROOTS.**—Roots are the anchors of the tree, and are also the channels of communication between the trunk and the root-hairs, which take up the water and such minerals as may be dissolved in it. The only activity in the root system is that of the smallest and youngest roots with their constantly renewed hair-roots.

**TWIGS AND BUDS.**—A twig is, strictly speaking, only the last season's growth. It has usually no lateral branches. Each twig was last year a bud, formed terminally or in the axil of a leaf. It was given its first impulse in spring by the rising of the sap containing food material stored during the winter in the cambium layer. As soon as the little leaves are well spread they cease to be dependent on the tree for nourishment, but instead help to build up the tree, beginning by lengthening their own little twig until it resembles the last year's twig which bore it. The arrangement of buds on a stem follows pretty closely that of the leaves, for most buds are formed in the axils of the leaves, and nourished by their subtending leaves. A bud which loses its leaf by accident early in the fall is stunted. Not all the buds formed on a tree have a chance to develop into twigs. A severe struggle for life goes on in the tree-tops, some of the factors of which are light and

heats. The terminal bud usually stands the best chance of developing, but if it has been bitten by frost, or eaten or rubbed off, the lateral buds then come to the front in the race, and the best situated of these develop, thus causing a forking of that limb. If all the prominent buds of a twig are killed, smaller, accessory buds are permitted to swell, if such are present; or so-called "adventitious" buds may form anywhere on the branch, starting from under the skin or bark.

Draw various buds. How are they protected? Distinguish between leaf and flower-bud. Watch them unfold. Are all the leaves which are to develop this year wrapped within the buds before they open? What surfaces are folded in? Why? Why are some buds larger than others? Break off some vigorous terminal buds and watch the result. What happens to a twig if the terminal bud should be a fruit bud? Study twigs to see what has happened to them. What do all the scars mean? Study old wounds and knot-holes. How soon do they heal? Does new wood form over the scar? What happens when a tree is girdled? The best way to prune trees that the scar may be healed?

After the general life relations have been studied and the children have been impressed with the close relations of the various parts of the trees, we turn to the individual tree. An impression of the tree as a whole may be emphasized at once. Is it a branching tree or is there a central axis from which comparatively small limbs branch? Is the foliage erect or drooping, etc.? To aid this work the children should make observations on trees at a distance until they are able to recognize ordinary trees far away on the hill tops. Excellent work has been done in drawing trees to get this effect both in black wash drawings and color. Free use of the camera will also add greatly to the enjoyment and usefulness of this work.

After the general appearance of the tree is known, the parts of the tree may be studied. The children should know the leaf, the flower, the fruit, the appearance of the bark, the appearance of the wood, the uses of any and all of these parts. Collections should be made having all of the above specimens represented, on one card if possible, a picture of the tree as a whole—blossoms, fruit, leaf, bark and wood—and any products of the tree.

The collection and careful preserving and arrangement of specimens forms a very material part of the work. The collections themselves form a basis for rough classification:

1. Needle-leaved, naked-seeded conifers (pine, cedar, cypress, etc.)
2. Broad-leaved trees (two-seed leaves), oak, poplar, etc.
3. Palms, yuccas, *et al.*

A little further work may be done in this line if the children desire it, as the few common oaks may easily be distinguished.

Great interest has been shown in a study of woods of the various trees. For this work the children should make collections of longitu-

dinal and cross sections of the limits of the trees studied (these can be finished off with sandpaper) to show the grain of the wood, the annual rings, any scars made by knots, the various parts as bark, pith, sap and heart wood, spring and summer wood, odor and color of woods. A young tree may be pulled up carefully and carried into the schoolroom to serve as a tree in miniature.

The products of trees opens a field of infinite possibilities, for wood is now, and has been, the most widely useful material to man, "from a match or toothpick to an ocean liner," entering into almost everything, and we are always interested in looking into the subject. The sap of trees is useful to us as sugar, resin, camphor, sago, rubber, turpentine, *et al.* The bark of trees is used for medicine, spices, tanning, *et al.* The fruits of trees forms an important part of our daily food.

#### PARASITIC PLANTS.

This is a good place to begin our study of parasitic plants, for our oaks and pines are often filled with the dark green bunches of mistletoe. This plant bears flowers and waxen, sticky berries, which are carried by birds and the seed dropped in a crevice of the bark. It germinates and sends its root through the thick outer bark into the living tissue of the tree, and from this tissue the mistletoe takes the crude food material as it flows upward in the twig. This is changed in the green leaves of the plant itself. The gray "moss" found hanging from our trees is another interesting form for study. The "moss" and lichen forms which cover the bark of trees and are often of such brilliant color, are representatives of a different type of dependent plants, for they do not get their food from the host, but merely use the host as a resting place, the food coming from the moisture in the air, and probably from the decaying bark of the tree itself. Many of these "air plants" can be seen in any greenhouse.

While interest is awakened in this subject, it is well to carry it as far as possible. The masses of orange and yellow dodder we are so familiar with on our marshes offers a subject of great interest, for here we have an example of a complete parasite. The seed of this plant falls to the ground and germinates just as the seed of its near relative, the morning-glory, sending a tiny root into the ground and a slender twining top up into the air. These growths are supported by the nourishment stored within the seed itself. The slender, thread-like stems sways and reaches from side to side until it touches some plant of another kind, and at once the orange threads begin to coil about the host. Wherever the stem touches the host plant, tiny blunt roots are sent out, which enter into the tissues of the host and steal the food supply. The tiny root which grew from the seed only acted as a support, and as soon as the dodder has captured its host this root and

the lower part of the vine die away, leaving the dodder plant entirely supported by the host.

Mushrooms, toadstools, puff-balls, geasters, birds'-nest fungus, rusts and moulds are well taken up in connection with this general study of parasites.

#### ANIMAL LIFE IN THE TREES.

Trees can not be studied without meeting a host of animals. Oaks are especially favorable for this study. We at once meet the wonderful homes of the various gall flies, and the variety of insects beneficial and harmful, and this inter-relations is a field of work that must at least be touched on. Birds are always associated with trees, for they feed upon these same insects and upon the fruit of the tree and help in spreading the seeds. We also find snakes, lizards, squirrels, *et al.*

The study of grafting, pruning and correct way of caring for trees interests certain children, and is suggested as a possible line of work.

This chart is suggested as a convenient way of keeping the data collected by the children.

#### TREE ZONES.

It is interesting in our work with trees to note the variation in kind according to the part of the country we are studying. We can separate the trees we are familiar with into six groups or zones, according to the places they live.

1. The Maratime Zone. Close to the sea. Trees which do not extend inland. (Monterey Pine and Torrey Pine, *et al.*).
2. Fog Belt Zone. (Redwood.)
3. Foothill Zone. (Digger Pine, Hickory Pine, Lake County Cypress.)
4. Timber Zone. (Yellow Pine, Black Pine, Sugar Pine, Sequoia.)
5. Sub-Alpine Zone. (Fir, Jumpers, Spruce, Hemlock.)
6. Alpine. (White-stemmed Pine.)

In all this work let us emphasize the beauty of trees and the charm they lend to every scene in nature. The development of the æsthetic side, to my mind, rises above all else in our work with children.

## GENERAL AND RECREATIVE READING FOR THE TEACHER

- Allen, Grant. Common sense science. Read: Holly and mistletoe, p. 76-89; *The winter rest*, 101-111; *The balance of nature*, 133-143; *Nuts and nutting*, 233-242.
- Ballantyne. Essays in mosaic. (Extracts from many authors.) Read: *Sympathy with nature*, p. 156-175.
- Burroughs. A year in the fields. Read: Winter neighbors, p. 13-20; A bunch of herbs, 125-158; *Autumn tides*, ch 7; *A sharp lookout*, ch. 8.
- .....Birds and poets. Read: Before beauty, p. 174-182.
- .....Fresh fields. Read: Nature in England, p. 3-36; English woods, 39-48; In Wordsworth's country, 161-172.
- .....Locusts and wild honey. Read: Sharp eyes, esp. p. 38-9; Is it going to rain? p. 79-105.
- .....Pepaction. Read: Nature and the poets, p. 91-129; Shakespeare's natural history, 186-194; A bunch of herbs, 209-235.
- .....Winter sunshine. Read: *Winter sunshine*, p. 1-30; *Autumn tides*, 115-128; *The apple*, 131-148.
- Fiske, John. Excursion of an evolutionist, chl.
- Pinchot, Gifford. A primer of forestry. See index.
- Prime, E. D. G. Around the world. Read: Yosemite Valley, p. 46-63; Big Trees, 63-68.
- Shaler, N. S. Aspects of the earth. Read: *Forests of North America*, p. 257-299.
- Thoreau. Excursions. Read: A winter walk, p. 109-134; *The succession of forest trees*, p. 35-160; *Autumnal tints*, p. 215-265; *Wild apples*, p. 266-300.
- .....Walden. Read: Solitude, p. 140-151.
- .....The Maine woods.
- .....Autumn. (See index.)
- .....Summer. (See index.)
- Winthrop, Theodore. Life in the open air. Read: The pine tree, p. 20-4; Umbagog (forests, etc.), 25-36; the birch, 46-54.
- Wright, Mabel Osgood. The friendship of nature. New York, Macmillan & Co., 1895. For sale by Whitaker and Ray. 40 cts. Read: *The loom of autumn*, p. 185-217; *A winter mood*, 218-238.
- Muir, John. Mountains of California. Read esp., *The forests*, ch 8, p. 139.

**Books for Reference in Oakland or Alameda Public Library**

1. Arthur and MacDougal. Living plants and their properties. (Twelve fine essays. Cf. chs. 1, 3, 4, 8, 9, 10, 11.)
2. Bailey. Lessons with plants. (The best books for twigs and buds in their life relation.)
3. Bailey. Talks afield.
4. Beal. Seed dispersal. (Much valuable matter in small space.)
5. Bergen. Elements of botany. (Extremely valuable as a source of information, and to suggest similar experiments.)
6. Britton and Brown. Illustrated floras of United States and Canada. (Reference department. Excellent to consult for tree groups and for weeds of wide distribution.)
7. Coulter. Plant relations. (No praise is too high for this exquisitely illustrated work; consult for life relations.)
8. Coulter. Plant studies.
9. Darwin. Movements and habits of climbing plants.
10. Darwin. Power of movement in plants. (2 chs. on sleep on leaf).
11. Detmer and Moor. Practical plant physiology. (Excellent for function of leaves, etc.)
12. Goddes. Chapters in modern botany.
13. Grindon. Trees of old England.
14. Hale. Little flower people. (Much information given in fairy tale style on uses of roots, stems, leaves, etc.)
15. Hemsley. (Handbook of hardy trees, shrubs, etc.)
16. Herrick. Chapters on plant life. (Very elementary.)
17. Herrick. Wonders of plant life. (A good short chapter on physiology of plants; non-technical.)
18. Kerner and Oliver. Natural history of plants. (Reference department.) (The great source book to which all elementary texts refer. Not too technical to be good reading. Charminglly illustrated.)
19. London. Trees and shrubs of Great Britain.
20. Lubbock. The beauties of nature. (Cf. for rel. leaves and rain.)
21. Mathews. Familiar features of the roadside.
22. Mathews. Familiar trees and their leaves. (Very valuable, although written for the East.) (Trees by families; key.
23. Muir. Mountains of California. (Descriptions by a master of the English language, of our best known coast trees.)
24. Newhall. Trees of north-eastern America.
25. Oels. Experimental plant physiology.
26. Pinchot. A primer of forestry. (No definite references made to this book below, as it has not so far been available for consultation. It is used in the nature study work of other California towns.)

27. Setchell. Laboratory practice for beginners in botany. (Questions and experiments mostly too advanced for primary and grammar grades, but very suggestive.)
28. Thome. Structural and physiological botany. (Old-fashioned.)
29. Vines. Physiology of plants. (Not so good as No. 30.)
30. Vines. Students text-book of botany. (Excellent for both structure and function.)
31. Ward. The oak. (A well written book on English oaks.)
- a. Alln, Grant. The story of the plants. N. Y. Appleton, 1899. For sale by Whitaker and Ray. 40 cts.
- b. Awdry, Mrs. W. Early chapters in science. 348 p. Illus. N. Y. E. P. Dutton & Co. 1899. Whitaker & Ray. \$2.00.
- c. Bergen, Fanny D. Glimpses at the plant world. 156 p. Boston. Ginn & Co. For sale at 321 Sansome st., S. F.
- d. Chase, Annie. Buds, stems and roots. Boston. Ed. Pub. Co. (S. O.)
- c. Cooke, Flora J. Nature myths and stories for little children. Chicago. A. Flanagan. Whitaker & Ray. 20 cts.
- f. Engell, Annie Gilbert. Outlines in nature study and history. 156 p. N. Y. Silver Burdette & Co. For sale 321 Sansome st. 50 cts. (Just out; an excellent book.)
- g. Lovejoy, Mary I. Nature in verse. Boston. Silver, Burdette & Co. 1895.
- h. Macbride, Thos. H. Lessons in elementary botany. 233 p. Boston. Allyn & Bacon. 1897. For sale 321 Sansome st. 60 cts.
- i. MacDougal. The nature and work of plants. 217 p. N. Y. The Macmillan Co. 1900. For sale by Payot and Upham. 80 cts.
- j. McMurray, Chas. A. Special methods in science for the first four grades. Bloomington, Ill. Public School Pub. Co.
- k. Morley, Margaret W. Little wanderers. Boston. Ginn.
- l. Murche, Vincent. Object lessons in elementary science. N. Y. The Macmillan Co. For sale 321 Sansome st. 3 vols. 60, 70 and 90 cts. respectively. (Very good indeed for desk.)
- m. Oakley, Isabelle G. Simple lessons in the study of nature. 164 pp. Illus. N. Y. William Beverley Harison. 1898. (Questions and summaries. Good.) Whitaker & Ray. 50 cts.
- n. Newell, Jane H. Outline lessons in botany. Ginn & Co. Part 1, From seed to leaf. 55 cts; Part 2, Fruit and flower, 90 cts.
- o. Pepoon and Maxwell. Studies of plant life. 95 pp. Boston. D. C. Heath & Co. 1900. For sale 321 Sansome st. 50 cts. (Good.)
- p. Scott, Chas. B. Nature study and the child. 618 pp. Illus. Boston. D. C. Heath & Co. 1900. (Excellent; contains both discussions on method and worked-up material.) 321 Sansome st. \$1.25.

- q. (No author.) Roots and stems. Boston Ed. Pub. Co. 1897. (S. O.)

### References for the Teacher by Subjects.

(Figures and letters in parenthesis refer to books in lists above.)

PLANS.—A n y botany; (1), (2), (5), (7), (8), (16), (18), (30), (a), (h), (i), (m), (n), (o).

Endogens and exogens (3), pp. 36-41.

Food of (see general head "Assimilation").

Life relations of (7), p. 142.

Light (29), p., 157.

Movements (9) chs. 1, 3, 4, 5; (10) ch. 7; (11) p. 534; (12) p. 34; (16) pp. 95-106; (20) see index.

Physiology (17) index; (30) p. 669; see also gen. hd. "Assimilation."

Protection of

Eucalyptus seed against drought (18) 2:449.

Fruit against animals (18) 2:444-7.

Feaves (see gen. head "Leaves").

Seed against wet (18) 2:447.

Storage (26) p. 58.

TREES.—(6), (7), (13), (15), (18), (19), (22), (23), (24), (26), (31).

Acacia, Leaves of (2) index; 1:324-347.

Ages of (20) index.

Beech (6) 1:513.

Birch (6) 1:503.

Buckeye (6) 2:400.

Cedar

Incense (23) p. 169.

Red (23) p. 205.

Elm (6) 1:523.

English (13), (19), index.

Fir

Red (22) p. 173.

White or silver (23) p. 172.

Forests of California (23) pp. 139-224.

Identification (22).

Linden (6) 1:413; (2) pp. 193-4 (cut of blossom).

Maple (6) 2:396; (2) index.

Mistletoe (2) pp. 338, 406 (6) 1:534; (18) 1:204-213.

Of Mountains (23) pp. 6, 8, 15, 45, 87, 111, 117, 121.

Mulberry (2) index; (6) 1:527.

Oak (2) index; (23) p. 224; (30).

Pine (2) index; (7) index; (6) 1:49.

Dwarf (23) p. 211.

Mountain (23) p. 203.

Needle (23) p. 217.

Nut (23) pp. 146, 219.

Sugar (23) p. 152.

Tamarack (23) p. 200.

Yellow or Silver (23) p. 163.

White (23) p. 215.

Poplar (2) — 79, 163.

Myth (e) 57.

Sequoia gigantea (23) p. 179.

Spruce (2) index.

Douglas (23) p. 168.

Hemlock (23) p. 207.

Walnut (2) index; (6) 1:483.

Willow (2) index; (6) 1:490.

Winter condition, Bailey. Leaflet No. 12, Cornell leaflets 1st ser.

LEAVES.—Any botany; (2), (3), (5), (21), index; (11) pp. 161-189; (27) index.

Autumn coloration (see color).

Budding and falling (m), p. 119.

Chlorophyll (2), (7), index; (11) p. 20; (18) 1:371; (1) ch. 8, p. 121.

Climbing (9) ch. 1.

Color, green, see chlorophyll.

In autum (1) ch. 9, p. 145; (7) p. 241; (11) p. 29; (18) 1:483.

Fall of (1) pp. 154-164; (7) p. 241; (11) p. 29.

Fall of (1) pp. 154-164; (7) p. 241 (cut of cleavage plate); (18) 1:355; see also Gould, Evergreens, and how they shed their leaves. Leaflet No. 13, Cornell Leaflets.

Forms of (5) pp. 85-93; any other botany.

Freezing, effect of (1) ch. 6, p. 85; (25) pp. 63-5.

Functions (7) p. 3, 28; (5) 124-5; (30) 685.

Assimilation (see general head "Assimilation").

Respiration (7) index; (11) p. 259; (18) 1:491.

Transpiration (7) index; (5) index; (25) p. 18; (30) pp. 696-700.

Light

Absence of (see Sleep).

Effect of (1) pp. 45-5; (7) index; (5) pp. 94-101; (25) 55-60.

Relation of leaves to (see Effect of).

Modified (2) pp. 96-114.

Movements of (see Sleep).

At Night (see Sleep).

Old and young (18) 1:347.

**Positions**

Acacia, etc., (18) 1:324-347.

Day and night (25) pp. 55-60 (see also Sleep).

Protection of (7), index;

Against animals (18) 1:430; radiation (18) 1:528; transpiration (18) 1:307-325.

**Relations**

Between position and form (18) 1:40.

To rain (7), (18) index; (20) index.

To roots (18) 1:92-99.

Sleep (10) ch. 7; (12) p. 84; (16) pp. 95-106.

Starch, Presence of (experiment) (5) p. 121.

Formation (see general head "Assimilation").

Stomata (see Structure).

Structure (any botany); (7) p. 28; (30) p. 45.

Minute (5) p. 108.

Stomata (11.) p. 168.

Uses (fairy tales about) (14).

**STEM.**—Any botany; (2), (3), (5), index; (27) p. 19; (d), (q).

Bark (2) p. 69; (7) 84; (27) 19; (m) index.

Buds (see general head "Buds").

Conducting tissues (see Structure).

Life relations (see Relations).

Relations general (7) p. 53.

To light (7) p. 72 (cut).

Resistance to strain (18) 1:724.

Storage of starch, etc., (27) index; (30) p. 41.

Structure (any botany).

Conducting tissues (5), pp. 52-66 (good cuts); (7) pp. 83,

151, 171, cuts; pp. 92, 94, 107-8; (30) 170-184.

Uses (fairy tales about) (14).

Work of (5), pp. 67-76; (27) 24.

**TWIGS.**—(2) index; (see also Bailey. Four apple twigs. Leaflet No. 3, Cornell Leaflets).

Buds (see general head "Buds").

**BUDS.**—(2) pp. 1-77; (4) index; (7) index; (26) p. 46; (d); see also Lubbock. Buds and stipules.

Adventitious (5) p. 33-84.

Dormant (5) p. 83.

On stems (18) 2:8.

Opening (11), 401-2.

Position (5) p. 79.

Scales (see Structure).

Structure (5) p. 77.

Scales (5) p. 78.

**ROOTS.**—Any botany; (2), (3), (5), (7), index; (18) 1:749; (27) p. 17 (d),  
(q).

Absorption (see under general head "Assimilation").

Climbing by (9). ch. 5.

Form (30), p. 61.

Functions (5), (30), index.

Of locust (4) p. 6.

Pressure (25) p. 13.

Relation to foliage leaves (18) pp. 92-99.

Root-hairs (18) p. 87 (cut); (25) p. 4; (30) p. 681 (cut).

Uses, fairy tales about (14).

**ASSIMILATION.**—Any physiological botany; (2) pp. 421-4; (5) p. 122;  
(11) ch. 1, pp. 1-106.

Absorption (30) pp. 692-696.

Of water (11) p. 185; (18) 1:216-230; (29) p. 48-68.

Carbon compounds (18) 1:452.

Carbon dioxide (11) p. 39; (2) 422.

Conveyance of food (2) p. 424; (18) 1:465.

Distribution of water, etc., (30) p. 700.

Food (see Nutrient materials).

Food for young plants (m) p. 96.

Metabolism (18) 1:455.

Nutrient materials (28) pp. 121-138.

Gases (18) 1:60-5.

Minerals (11) —82.

Salts (18) 1:66-75.

Salts and land plants (19) 1:82-91.

Solutions (formilæ) (25) p. 1.

Organs of (11) p. 35.

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Disappearance in dark (25) p. 44.

Formation (25) p. 36.

Grains (11) p. 163 (cut).

Iodine test for (11) p. 114.

## PLANT SOCIETIES

Our work during the earlier years is largely confined to problems concerning the individual plant. We experiment with seeds, with single plants, with trees, but after this study and as a fitting outcome of

our work, we are to consider the plant in its relation to other plants and look for the explanation of these relations in the external influences that are acting upon and influencing the organization of what we shall call "Plant Societies." By this we mean plants that live together in communities, being driven together by circumstances.

In our previous work we have brought out the fact that each plant is made up of a combination of organs that have been developed in response to some stimulent exerted by the environment of the plant.

To prepare us for a better understanding of these plant societies, it might be well to consider a few of the most salient factors in what has become familiarly known as the "Struggle for Existence." We are perhaps better acquainted with this struggle among the animals, yet the sharpest struggle is as surely going on about us in the plant world. We have but to look for a moment into the branches of our oaks or to walk across our lawn to realize this. Every meadow, roadside, hill or valley is the scene of fiercest strife, and far greater is the destruction among plants than among animals, for they are of necessity slower in adapting themselves to new conditions.

Let us consider some of the chief factors in this struggle for existence:

*Water.*—Certainly this is one of the most important factors in our study. We find on one hand plants that live entirely within water, and grading away to the other extreme we come to plants of the desert which at best can obtain but a meager supply of moisture. Certainly anything that comes in to interrupt the normal water supply, be it through natural or artificial human agencies, is going to change the character of our plant society.

Let us consider a common example of natural changes that are going on about us everywhere. If we look at any small lake or pond of water we see, perhaps, growing about it bulrushes, cat-tails, grasses and reeds. These are distinctly water loving plants, and are characteristic of all water scenes. As these grow they are always found moving forward into the water. Their roots are far-spreading, thickly-matted masses, and form excellent nets for catching every bit of floating rubbish, silts, etc., that may come in the water. Gradually our lake banks have become bogs, and these bogs change in turn into dryer and dryer ground. Now our conditions are entirely unfavorable for the water-loving rushes, and they must adapt themselves to conditions as they are or perish. But they change too slowly for this adaptation, and almost immediately their place is occupied by the myriad forms of plant life which are already adapted to just the existing conditions.

As a contrast to this natural change, we may consider the case of an artificially drained field, by which means men regain land for their own purposes; or again consider land that is cleared of forests. While the forest was growing it acted, through the deep layers of fallen leaves

and its roots, as an enormous sponge, keeping in reserve great supplies of water that are drawn upon during dry periods. When these forests are removed the water is no longer held back, but pours off in floods, giving us long periods of drought.

In considering the water supply it is not enough to concern ourselves with the annual amount, but also the distribution through the year. Do we get a uniform fall of rain, or do we have alternating flood and drought? Do we find our water supply furnished by subterranean channels or surface streams, or through rain and snow?

We can do nothing with our plant work without making a study of soils. The variation in dept of soil is an important factor in determining plant life. And the varying power of different soils to absorb and retain water is another question to be considered.

Still further we must recognize the various substances contained in water as influences in determining plant forms.

*Light.*—In the growth of all green plants, light is certainly a most important factor and we find a keen struggle taking place among leaves of a single plant, individual against individual, and society against society for the supply of light. There is great variation in the amount of light necessary to the growth of various kinds of plants, as for example the common sun-loving weeds that bask in open meadows or upon sun-steeped hillsides as contrasted with our ferns and mosses, lovers of the cool, dark shades of our river banks.

If we consider any small, thickly-wooded dell we find tall trees towering high over head, throwing far and near their sun-seeking leaves. If these trees are not too dense, lesser bushes will thrive; below these, in turn, we find tall herbs, lower herbs, small creeping, low-spreading plants, and finally mosses and lichens clinging close against the ground.

Our own oak groves are excellent examples of an open forest, and an excellent contrast to our coniferous forests or eucalyptus groves.

*Temperature.*—We may consider here the annual changes in temperature that make a marked difference in our plants at various times in the year. When working with this problem the temperature of the soil as well as of the atmosphere will be important, for it will have great effect upon the growth of the roots. Attitudinal changes bring about wonderful modifications in our plant forms. Under this head we might speak of the effect strong winds will have upon vegetation. Excellent opportunity is given us for this study along our sea coast and open stretches of prairie land.

*Soil.*—In talking up this subject, I shall consider roughly the various kinds of soil that are easily recognized in ordinary field work. Quoting directly from Coulter, "Soils may be roughly divided into six classes: (1) *rock*, which means solid, uncrumbled rock, upon which certain plants are able to grow; (2) *sand*, which has small water capacity, that

is, it may receive water readily enough, but does not retain it; (3) *lime soil*; (4) *clay*, which has great water capacity; (5) *humus*, which is rich in the products of plant and animal decay; (6) *salt soil*, in which the water contains various salts, and is generally spoken of as alkaline."

The soil cover should also be studied as an important factor in diminishing extremes in temperature and increasing the retention of water. These soil covers are usually fallen leaves and growing plants (snow concerns us little). If we study soil that is subjected to occasional floods we find great changes coming about in our plant forms, due to the deposit of new soils. Shifting sand dunes are constantly encroaching upon interior areas, changing the general type of plant growth. Man artificially changes soil composition by clearing lands, draining and fertilizing, thus producing both chemical and mechanical changes.

*Devastating animals*.—The ravages of animals plays an important role in plant life, for we are very familiar with the effect of certain burrowing animals upon plants of the field and garden. The gopher may be taken as an example of this type, the injury caused to plant life by grazing animals, such as sheep, cattle, *et al.* Leaf-eating insects offer excellent opportunity for observation, as examples are many of serious damage being done by insects. Our own oaks have been destroyed by the larva of the Phryganidia moth, and no line of work could offer greater facility for study. The important field of scale insects, the destroyer of our orchards, may also be entered upon.

How do plants protect themselves against these destroyers? Here is a line of work offering endless variation and opportunity for individual observation and new discovery. Nothing could offer greater delight than a study of the many ingenious methods for protection displayed in hairs, prickles, thorns, bitter or poisonous secretions, cutting edges, uneatable tissues, by mimicking the appearance of dangerous or uneatable plants or pebbles or earth, and thus being overlooked; protection by a body guard of ants.

*Plant rivalry*.—Let us but consider the many plants eager to occupy every inch of the ground, and instantly we will realize how sharp must this rivalry between plants really be. The plant is going to survive in this struggle, which can most nearly utilize the conditions that exist.

After considering some of the important factors in determining plant societies, I shall try briefly to characterize a few of the common forms of societies, that it will be possible for us to make use of in our work. I should suggest that the child be set to observing any plant society that he comes in contact with, so that he shall learn the plants that characterize it. In our local gardens we have the same kinds of weeds, but though dandelions grow in our lawns, they will not grow in marshes nor in deep-shaded eucalyptus groves.

We want to consider two things in this observation work and they are (1) certain plants associate; (2) any one plant is not equally dis-

tributed everywhere. Now our question is, why are these things true?

With this as a beginning we are in a position to understand the great world types of plant societies.

It must be kept in mind that all clear cut grouping is artificial, and its only excuse for being is that it aids us ultimately in bringing out a clearer understanding of plant life under the various conditions presented in the world.

We will first consider *Water Plants*: Though the plants of this group are world-wide in their distribution, there is a marked simplicity in their form, due, of course, to the uniformity in conditions brought about through the modifying medium of water.

We find water plants adapting themselves to their environment in several general ways. (1) They are submerged, and thus the entire plant is exposed for the absorption of water, while in other plants the roots perform this task. The epidermis, therefore, is thin, while in other plants it is thick for protection.

(2) The roots of these water plants are much reduced, or are wanting, as the entire plant performs the office of absorbing water. The roots are often retained merely to anchor the plant.

(3) As we find no definite flow of water from the roots to the plant, we find no water-conducting tissues.

(4) Water has such buoyant power that plants are supported without the firm mechanical tissue that is so abundant in our common plants, especially in our trees. This can easily be seen by lifting a water plant up, when it will at once collapse.

(5) Beside these modifications we find many water plants developing air cavities. These are necessary (1) to ariate the plant and (2) to increase buoyancy. Often these air chambers are in the body of the plant, but where special buoyancy is needed regular floats are developed. These are very common in seaweeds and bladderworts.

It is well, in taking up this work, to have as many examples of the various societies as possible. If we first consider *free-swimming* societies we should have examples of plants that are entirely submerged in the waters, as well as those that float. Some lower forms possess the power of locomotion, while others are carried about by currents in the water. Diatoms are examples of the former, and are to be found in almost any stagnant water, but can only be seen with a microscope, so are not very practical for our work. The various depths at which submerged forms live is a subject for experiment. It will be interesting to note the type of leaves common to submerged plants is narrow, while the leaves of floating forms are broad. Our common duck weed is an easily found example of the floating, free-swimming society.

*Pondweed societies*.—These societies have a definite relation to the soil, for they are fixed by roots, though their leaves may be submerged

or floating. A few of the more easily studied groups will be taken up here.

*Rock societies.*—Under this head we shall group all plants that are firmly anchored to any support beneath the water. We have a great variety of both fresh and salt water algi that can easily be studied. Often we find salt water algi fastened to rocks by suckers and supported by floats. The food supply is, of course, greater where the water moves more rapidly, and we find these sea forms bound firmly where tides roll highest. The color of our water plants can well be studied in the seaweeds, varying as they do with depth from the vivid green through blue, brown to red.

*Loose soil societies.*—A great variety of pondweeds, waterlilies, water-buttercups, mosses, algi, *et al.*, may be contrasted with the *Rock societies*, as they live in loose soil and are definitely dependent upon it, not using it merely as a support. The great, flat, floating leaves of lilies are deep green. They grow from masses of interweaving roots and stems below the water. In studying the water-buttercup an interesting comparison can be made between the leaves that are submerged, which are pale in color and are broken into narrow lobes, while the leaves that float upon the surface are broad and green. The flowers are always sent up to the surface.

*Swamp societies.*—Plants that are rooted in water, but having thick epidemis and rigid mechanical tissues, and are provided with no floats, as they stand free from water, are grouped under the general head of swamp-societies. These are most important factors in turf building.

A few general divisions of this great group may be suggestive. On the borders of ponds and lakes, we find growing in deep still water numbers of tall, unbranched, wand-like forms like cat-tails, bulrushes, reed-grasses, *et al.* These we may call *reed-swamps*. As these plants collect silts, meadow-like expanses of swampy ground are formed where grassy plants predominate. The water is rich with food material and buttercups, sedges and coarse grasses flourish. This we may call a *swamp-moor*. Gradually this ground dries, and shrubs and trees find conditions favorable to their growth. Willows and alders, *et al.*, are often found under such conditions. These are *swamp-thickets*.

The sphagnum-moors, bog or peat mosses have awakened much interest in Alaska, and children are constantly bringing in specimens. The moss is pale yellow in color. The lower part dies and the upper part of the plants branch and grow, forming turf many feet in depth. The food material is lacking in these moors, so few varieties of our more familiar plants are found, but saprophytes (plants that obtain food from decaying materials in the soil, mushrooms being good examples of this type) and carnivorous plants abound. Decay in these bogs is slow, for bacteria do not thrive under such conditions.

Wonderful forests of coniferous trees are often found associated with the sphagnum-moors.

Turning from the water-loving plants to the other extreme we find a wonderful world of *drought loving* societies. These plants are adapted to dry air and soil. The problem that ever confronts these societies is the problem of water supply. This may present itself in one of three ways: (1) It may be only to provide against possible periods of drought coming at irregular intervals or (2) it may be to provide against *periodic drought* coming at regular, definite periods, or (3) it may be a *perennial drought*, which is constant upon deserts or arid arias.

It resolves itself, therefore, into the question of (1) how shall the greatest quantity of water be collected and retained? and (2) how shall the plant prevent loss of water? Striking structures have been developed to provide for the regulating of transpiration (or the giving off of water by plants). Roughly speaking, two general methods are adopted for this: (1) the leaf exposure is lessened or (2) exposed surfaces are protected in such a way that water does not easily escape.

The way in which various plants adapt themselves to these trying conditions makes an interesting subject for study.

(a) Many plants, such as lichens, mosses, resurrection plants, *et al.*, *dry up completely*, offering no resistance to the dry conditions.

(b) *Periodic reduction of leaf surfaces* is seen in our annuals which die, leaving only well protected seeds. An interesting habit is shown by all bulbous and tuberous plants. The plant above ground dies, and all life withdraws under ground, where life is maintained until moisture again develops the parts above ground. Exposure of leaf surfaces is greatly reduced by the common deciduous habit, which serves quite as well for cold periods. When moisture and warmth return the work of the plant is renewed and new leaves are developed.

(c) *Temporary reduction of surface*.—At the approach of periods of drought, leaves roll up in various ways, thus reducing surface exposure. An interesting comparison may easily be made between the grass leaves of a well-watered lawn and those of a dried-up lawn.

(d) *Fixed light positions*.—Generally in maturity leaves are fixed in their position, and this position depends largely upon the amount of light received during development, and the leaf is so situated that the amount of light received is just sufficient for the work of the leaf. If plants develop under intense light, the leaf will be in a profile position, that is, the apex of the leaf or leaf margin will be directed upwards, and the two surfaces will be exposed more fully to the morning and evening rays of the sun, which are less intense than the rays of the midday sun.

(e) *Motile leaves*.—Other plants retain throughout life leaves that move to accommodate themselves to the varying needs of external conditions. *Oxalis* is a common example of such plants, and others of the Leguminosæ group. Sensitive plants, acacia and mimosa forms, are

most notable, and are common in arid regions. The leaves are large but branch into numerous leaflets, each having the power of independent movement. If drought threatens some leaflets will fold up; if drought is prolonged more and more leaflets will fold until finally the entire plant is folded up.

(f) *Reduced leaves*.—An interesting comparison may be made between leaves that have grown in a river bottom, and leaves of the same plant grown on dry sand dunes. The absence of any large, showy leaves marks one of the most striking features of an arid region. Pines, sedges, heath plants and, as a climax, cactus plants, where leaves as foliage entirely disappear, their work being done by fleshy stems, mark the characteristic flora of such regions.

(g) *Hairy coverings*.—In place of this reduction of leaf surfaces, we often find leaves with hairy covering, which act as a sun screen. These hairs are dead and are filled with air so they reflect the light, thus giving them a white appearance and diminish the amount of light received by the plant. Mullen is an excellent example of this.

(h) *Body habit*.—The dwarfed growth of the entire plant in an arid region is a reflection of the environment. The dwarfed stature, slender, prostrate or creeping plant offer less exposed surface to the drying conditions. The rosette habit is common in arid regions, and the development of thorns is a very common characteristic. Under favorable conditions these thorns can be made to develop into leaves.

(i) *Anatomical adaptation*.—A layer of thick cuticle often covers the epidermis of leaves for protection and reduction of loss of water. The cells within the leaf are also so arranged as to offer the least exposure to the direct sun's light.

We must also devote some attention to the development of water reservoirs within many plants. A portion of the plant body is given over to this work. Succulent leaves are, perhaps, the most common form we shall find. The cactus plant with its globular body is perhaps the most important adaptation, as this form offers less exposed surface at any one time, and the greatest storage capacity is secured. Similar structures are often found in plants exposed to intense heat or wind.

The societies that we can consider under this group of drought-loving plants are:

*Rock societies*, as lichens and mosses.

*Sand societies*.—(1) Beach societies, which grow near the water, having poor flora and characterized by tufted and creeping plants.

(2) Dune societies, which lie next beyond the beach societies and overlap them, are movable, so the plants are few. Those which do exist are "sand binders," having wonderfully developed underground structures, their roots running to remarkable distances, both horizontally and vertically, thus gaining a stronghold upon the shifting sands. Beside this underground growth these "sand-binders" must have the

power to grow up through sand after they are completely engulfed by shifting sand.

(3) Sandy fields stretch beyond the dunes, and are characterized by tufted grasses and low shrubs.

*Shrubby heaths, plains and cactus deserts* may be taken up largely with the help of pictures and reading.

*Thickets*, or as we know them, "chaparral." These societies are common in our own state and are well described as growths which are scraggy, thorny and impenetrable. The "chaparral" is composed usually of mesquit bushes, acacias and mimosas.

*Forests*.—I should like here to call attention to the association of this work with the work that was begun last term with trees. Again an opportunity offers by which the great *zones* of forest trees may be studied to advantage.

1. The coniferous forest is made up of various cone-bearing perennial trees. The leaves are needle-like with heavy walls.

2. *Foliage forests*, as our eucalyptus, oaks, *et al.*, having lance-shaped leaves which are stiff and leathery.

3. *Leafless forests* represented by the giant cactus.

Turning from these two extreme types of plant societies we shall consider those plant societies which make up the common vegetation of our temperate region. We find in these normal plant conditions no need for special adaptation. Great diversity of leaf foliage characterizes this medium group of plant societies, and a great variety of plant forms are represented. For convenience we shall make up two classes of societies: (1) Societies made up of low vegetation, calling them grass and herb societies, and (2) societies made up of higher woody vegetation, or trees and shrubs.

1. *Grass and herb societies*:

*Arctic and Alpine carpets*.—These societies are of rapid growth and are intensely green, showing activity. They grow from well-developed underground structures. They are low in form, for the season is short and the temperature is low. Life is of short duration, so we have soft structures as there is no need for rigid support or resistance. Intense color and often great size of flower characterize these societies.

*Meadows* are natural arias of rich, moist soil, covered with a mixture of clovers, flowering herbs and grasses. They are often connected with open forests. The true meadow will, however, be hard to find in this country.

*Pastures* are dryer than meadows, and include our common, artificially cleared areas. (See suggestions for study on last page.)

2. *Woody societies* (trees and shrubs).

*Thickets*.—The thickets of this medium group of societies do not develop so abundantly nor are they so impenetrable as in the arid regions. They are often composed of willows in the colder regions.

*Deciduous forests* shed their leaves at the approach of cold weather, thus decreasing surface exposure. Compare this method with that of the coniferous type of trees which meet the same problem in quite a different way, having long, narrow leaves. The conifers are saved the annual renewal of leaves, but lose greatly in working power, while the deciduous trees must renew their leaves annually, but they gain in working power.

*Evergreen foliage forests* are well represented here by imported foliage trees. The glossy leaves shed water, thus preventing too great a supply.

A still further grouping of plants may be made, not according to the artificial grouping based upon the amount of water needed, but upon the food material contained in the water. These materials are usually salt, gypsum and magnesia, and are called salt or alkaline soils. These societies are found (1) in the vicinity of seashores, beaches, swamps and meadows; (2) on the margins of salt lakes; (3) about salt springs; (4) interior arid wastes. These plants have usually succulent, translucent leaves, showing the presence of water reservoirs and a lack of green coloring matter. Comparatively few plants are able to endure such conditions.

#### SUGGESTIONS FOR WORK.

Field observation is necessary, and the pupils must keep specimens of various societies studied with written notes of explanation. Beside these, all pictures illustrating the various societies are to be collected and cared for by pupils.

Each pupil shall be given some common society to report upon. These may be from an adjacent field, bit of road side, lawn or garden. Are the weeds native or foreign? Are they annual or perennial? If the field or lawn is being invaded, what is the relative success of these invaders, and account for their success? What conditions are favorable to the development of dandelion, dock, chickweed, alfilaria, *et al.* What plants thrive in oak groves, eucalyptus or pine forests? What kinds of plants grow in fence corners? Are they the same as those that grow in woods, or wheat field, in the garden, *et. al.*?

Have children clear a one-foot patch of ground and watch weeds that come up on this. Get number of different kinds and see which succeed in life, and try to understand why.

Work with any animal destroyer of vegetation.

Insect pests—Leaf beetles, larva, *et al.*

Scale pests—Animals that live in the various societies.

Consult special reference catalogue.

## CLIMBING PLANTS

Plants become climbers in order to reach the light and to expose a large surface of their leaves to its action and to that of the free air. This is effected by climbers with wonderfully little expenditure of organized matter, in comparison with trees which have to support a load of heavy branches by a massive trunk.

Climbing plants may be divided into four classes. First, those which twine spirally around a support and are not aided by any other movement. Second, those with irritable organs which, when they touch an object, clasp it; such organs consist of modified leaves, branches, or flower-peduncles. Third, those which ascend by means of hooks. Fourth, by rootlets.

## TWINING PLANTS.

*Hop*.—When the hop vine first rises from the ground the first two or three joints or internodes are straight and remain stationery, but the next-formed soon begin to move slowly around, moving with the sun or with the hands of a clock. As these shoots grow they soon move more rapidly. As long as the plant grows this revolving movement continues, but each internode, as it becomes old, ceases to move. Each revolution made averaged 24 hours. The movement of the ever-growing moving end of the twining plant is to aid its shoot in finding a support. The revolutions are continued night and day and as the shoot increases in length a wider and wider circle is swept. As soon as a support is found the motion is necessarily arrested at the point of contact, but the free end projecting beyond the support goes on revolving.

In watching the movement of the hop vine it would be well to mark a line along one side of the moving internode and observe the spiral position taken by this line. Where the vine is greatly twisted it would be well to see the cause. Is this for the purpose of gaining rigidity? Try various supports, as smooth glass rods, rough sticks, smooth sticks, threads, and discover if any preference is shown; test also to discover the size of support most suitable. Are any too large for the plant to make use of? What do twiners do when they grow beyond their support? When a twiner begins to wind about a support, does it have the power to unwind again? Does the vine exert any pressure against the support? Discover how great this may be if possible. Do twiners wind more rapidly in windy, calm, stormy, clear, warm weather, at night or in day? Cut off some healthy climbers and keep them in water and see if movement increases or decreases.

Contrast with the hop vine a morning glory. This will twine about the support from left to right or against the sun or the hands of a watch.

Do your outdoor observations show you that more twiners move from left to right or *vice versa*?

#### LEAF-CLIMBERS.

The second class of climbing plants include those which ascend by the aid of irritable or sensitive organs. These shall, for convenience, be grouped under two sub-divisions. First, leaf-climbers, or those which retain their leaves in a functional condition, and second, tendril-bearers.

*Clematis* is an excellent example of the leaf-climbers, for we can so easily study the cultivated and wild plants. The petioles or foot-stalks are sensitive, and when they come in contact with some support they clasp it, revolving several times about the support, and then in many cases turning back, revolving in an opposite direction. The petiole that grasps the support develops greatly; this thickening is probably to insure the proper support of the vine. Not only does the petiole become thickened, but it also grows very tough, differing greatly from the ordinary uncurled petiole, which is brittle and easily snapped off. These petioles often grow dark red in color as they grow thick and tough. After the petioles have remained twined about a support for some time, they lose their power of motion.

#### TENDRIL-BEARERS.

By tendrils I mean filamentary organs, sensitive to contact and used exclusively for climbing. Thus we exclude spines, hooks and rootlets, which are used for climbing.

True tendrils are formed by the modification of leaves with their petioles, of flower-peduncles, branches, and perhaps stipules. We find various types of tendrils, some long, others short, and with or without branches. They have the tips provided with hooks, and as the tendril revolves and touches a support of any kind, the tendril, which is often sensitive to the slightest touch, begins to revolve. Not as with twining plants, in the direction of their revolving movement, but in accordance with the position of the stick and the side which is first touched. The tendril begins to contract into a spiral in a short time after it has touched its support, and this spiral, in the case of tendrils of any length, will be found twisting in opposite directions, that is, half the spires will turn in one direction and the other half will turn in an opposite direction, being separated by a short, straight portion. The number of spirals on each side of the straight portion will be the same, for what is wound up on one end will be made up for on the other. Wind a piece of tape and illustrate this point. If all wound one way and if wound in a figure 8, as a shop girl winds ribbons. If the tendril is not attached to anything it often coils loosely, all the spires, of course going in one direction, for the end is not attached. In many cases, however, a tendril that fails to attach itself to a support droops, grows slender, dies, and falls off.

The spiral form of the tendril aids greatly in pulling the young shoot upward and directing its growth in the most direct way. This also distributes the strain equally among the various parts of the plant,

and the wonderful elasticity gained prevents the plant from being torn away from its support during heavy storms. After tendrils have firmly caught a support they grow much thicker and tougher, and it is wonderful to observe the weight they are able to support and the length of time they retain this strength and elasticity even after they are dead and exposed to weathering.

Notice the way some tendrils develop suckers at tip of tendrils with which they cling to wood. Do all the branches of the pea tendril contract, or does the central branch remain straight? Test sensitiveness of tendrils. Try various sized supports. See the wrinkles along the tendril; are old tendrils sensitive?

#### HOOK-CLIMBERS.

Many plants, from their habit of growing beneath other plants, have developed the power of climbing as they have stretched toward the light, and as they are protected from the wind have developed long flexible shoots that scramble up through shrubs and trees. These climbers seem to possess no revolving movement, and depend entirely upon spines, thorns, branches, *et al.* One common climbing rose ascends the walls of a high house, if provided with a trellis. Some of the strong shoots tend to avoid the light and creep into cracks and crevices, thus it may be that they crawl between the wall and the trellis, and the later lateral shoots in turn seek the light and grow out and away from the trellis.

#### ROOT-CLIMBERS.

These climbers also seem to have no power of movement, light not even seeming to effect them.

Some secrete a fluid that is viscid enough to be drawn into threads; this fluid in turn cements the rootlets to a smooth surface like glass. Ivy will barely adhere to glass.

#### MALLOW

Out-of-doors observations, before work taken up in class-room.

Where does the mallow grow? How was the child sure he saw the mallow? Do these round leaves love the sun? Notice their arrangement on plant so that no leaf shades the neighbor. Notice the way the leaves follow the sun? Watch a leaf on the way to school at noon time and at night. Where do the flowers grow? What color are they? Do they go to sleep and at what time? What is the plant good for? (Beautifies waste places.) Does it stand up straight or creep? Why? How high does it grow?

*Roots.*—Are the large plants hard to pull up? How are they fastened into the ground? Do the roots go straight down, or do they branch out at the sides? What are the little roots for?

*Leaves.*—Uses: make plant pretty and cover up flowers and seeds when cold. Positions: turn toward light; often stem prostrate when not sheltered. Young leaves protected by and coming out of the axil of large leaves. How do the leaves fold up? Fold up a piece of paper in same way. What do they do when it gets cold?

*Flowers.*—Position: axil of large leaves. How long in the season do we find these flowers? How are they protected?

*Fruit or "cheeses."*—Positions: under leaves. How kept warm? How are the young seeds protected? Find the oldest cheeses? What color are they? Break these apart and see that each bit looks like a section of an orange.


#### SCHOOL WORK.

*Root.*—Take up some of the plants carefully and put in a jar of water so that the roots may be seen. The plant was withered when put in the water, see how long it will take it to recover? Remove all the fine roots and the plants will not live. What do these fine rootlets do for the plant? Dissolve salt and sugar in water and explain the way mineral water thus get into the plants.

*Stem.*—Positions; use: to fasten leaves and flowers to root, and carry food and water from the root to the leaves and flowers. To lift leaves and flowers into the sun. What color, length and shape?

*Leaves.*—Use of leaves. What happens to them when we break them from the stem? Why? How are they fastened to the stem? Notice the long green stems of the leaf, flat on upper side and round on lower. Why flat above? Hollowed out to make room for the young leaves. Shape of the "blade" of the leaf? Round with a deep cut where joined to the leaf-stem with the scalloped edge. How is the broad blade held out to the sun? Where do their veins start from? How many are there? Other work of leaves, breathing and taking in food. Experiment.

*Flowers and fruit.*—Flower the final goal of the plant. The most important part. How have we found the root, stem, leaf working for the flower? Where does it grow from the stem? One flower only or in clusters? How are the young flowers protected by the leaves? Notice carefully the flower in various stages of development. Notice that the flower is first on the short stem, which grows longer as the flower gets ready to open. Study the parts of the flower: Green outer part with five points; the pink part with five divisions; the white tree-like stamens and stigmas. What is the use of each part? The green calyx? Protect the bud. The pink corolla to protect stigmas. The use of these may be entered upon with older pupils. See in an old flower the developing seed box or cheese, and discover that the flower makes the cheese. Study the ripe seeds as they fall apart. Why so many? How do they spread? Plant some of the seeds and notice the earliest leaves. Compare with this the flower of the common single hollyhock.



## BUTTERCUP

Where does the buttercup grow? Where are the largest flowers found? How high do they grow? How do they grow, standing up or creeping? Much branching? Where are the flowers, under the leaves or lifted above them? Why? How are the young leaves and flowers taken care of? Take up a few plants and carry into the school-room, being careful not to break the small roots. Again speak of the work of roots holding fast and getting food and water. Which holds in the ground better, the mallow or buttercup? Why? The roots are interlaced, and usually several plants grow up together in a clump. Where are the largest leaves found on the plant?

*Stems.*—Their work reviewed. See that they are hollow.

*Leaves.*—Review work of leaves. Call attention to shape and way each plant is supported. Call attention to the endless variety of leaves, and see how much pleasanter it is that we are ever delighted with this variety.

*Flower.*—What has been done to make it and what the flower can do in return. The delight the color is to us. Note the glistening upper surface of the leaf and the duller under surface. How many yellow leaves? How are they covered up before they are ready to come out? Find the green furry coats which cover the bud and often drop off when no longer needed to protect the flower. The golden crown or petals fold over a great mass of dusty stamens which guard as a body of soldiers the rough topped pistil. Look carefully below these stamens, just at the base of each petal, and find the tiny scale which turns up like a cup, holding its drop of honey. Tiny little dark lines lead from the outer broad leaf like tiny paths to this cup of honey, and here the bees come to drink, and while busy with the honey or eager to find it they tumble about among the dusty stamens, covering themselves with the yellow pollen. Now this dusty bee flies off in search of more honey, and while he is tumbling about over the flower he is almost sure to hit against the little green knot on the pistil. This is sticky and holds the pollen fast. This is usually the way the pollen is carried, and no flower can be better to use as an introduction to the fascinating study of the relations of plants and insects. The use of the pollen for ripening the seed may be taken up as the age of the children dictates. Find the short stem of the stamens and the round ball where the yellow pollen is. Do all these balls open and throw out their pollen at once, or is it done a circle at a time? The inner circle often cast pollen upon the stigma and thus fertilizes their own seeds. Discover that the rough green ball develops into a ball of seeds, each having at the top the tiny curved hook. How are these seeds scattered? Do we make any use of the buttercup? The Indians used the seeds as food, grinding it into a flour. Do animals feed upon it? Why not? Let the children taste of

it carefully. This is a good plant to begin the work of plant protection, for this will suggest one way that plants keep themselves from being eaten.

### ALFILERILLA (Filaree)

This is an excellent plant for study, as it grows abundantly everywhere, and children are familiar with it. They all know the seed for children call them "clocks." How does the plant look when first coming out of the ground? Notice the rosette of leaves lying close upon the ground. The way each leaf fits into its neighbor so that all may get the greatest amount of sun. The shape of the leaf as compared with others studied. Do these plants branch? (some varieties grow to considerable height.)

How do the flowers grow, concealed as in the mallow or do they grow up on long stems, rising above the green leaves? How many grow on each stem? How are the buds protected? Do they have hairy green covers? What color is the flower? How many petals? Find the stamens. See if all bear pollen. Look for developing seed.


The seed is certainly the most interesting part of this plant to children. The seed vessels look like groups of long-billed storks. When the seed is ripe it breaks away from a central axis and begins to curl about any convenient object. This long beak is bearded which helps it to hold fast and also to travel. The winding of the long beak helps the seed to plant itself, for if the seed falls to the ground the sharp-pointed, strongly-bearded seed is worked farther and farther into the earth with each twist of the long beak. Often we find the fur of animals and even our own clothes covered with these tiny seeds that are fastened by their coiling beaks.

The plant is very useful as a forage plant. It might be a good plant to begin our work on the relation of plants and animals. What animals like it? How does it taste?

### MUSTARD

Dwell upon the beauty of this often overlooked or despised flower. Read H. H. Jackson's charming description of the mustard field in "Ramona." Call attention to the great fields of gold about our own city. What use did the early mission padres make of the mustard? Tell the story of the way they scattered seed to show them the way from one place to another.

Find the honey cups in the flowers. Watch the flowers open and see that those on the top of the cluster are late in developing. What do the seeds look like? How do they grow? How taken care of? Many or few? Does the plant lift them above the leaves? Are the leaves near



the ground like those high up near the flowers? Is the stalk hollow or solid? Thick or thin? What birds love to hide in a mustard field? What insects do you find visiting these flowers? Make a careful list of all insects seen visiting the mustard. Have children bring in specimens so that you may help in identification.

## BIRDS

**GENERAL DIRECTIONS.**—For the first lesson ascertain roughly the extent of the children's present acquaintance with feathered folks, as follows.

Divide a page into two columns. In first column have children write names of all the birds, wild or tame, that you have ever seen *alive.*" (When the class has finished this continue:) "In the second column write names of birds you have *heard of*, but have never *seen.*"

It will take one or two periods to complete this, but I should like to have it all done during the same session (half day) in which it is begun.

For a general lesson on birds, return to the children the papers on which they have written the names of the birds they have seen alive, and those which they have never seen, but have heard of, and work first with the former list. Ascertain who has the longest list. Take his paper and, having put heading on the board as indicated later, read the names one by one, and have the class tell which column to write the name in. Headings should be about as follows:

### TAME BIRDS.

### WILD BIRDS.

Cage Birds.	Domestic Fowl.	Local Birds.	Not Local.
Canary, etc.	Chickens, etc.	Owl, etc.	Eagle, etc.

In putting names on the board, write down the more desirable name of a bird, if the child uses the less desirable one, as "house finch" in place of the child's terms "red-head and linnet;" "English sparrow" instead of "chippie." If the child reports having seen wild any bird not named in the following list, it is either not a local bird, or else the child has applied a wrong name to a local bird. If the tangle can not be straightened out by discussion and description, throw the name out. After tabulating all the names on the paper first chosen, take the next longest, and add any new names it may contain, and so on, until there is on the blackboard a list containing names of all the birds any one in the class has ever seen alive. Have this copied in duplicate, one copy for me, and one for the class; the latter to be posted or kept at the teacher's desk. Of the lists, that containing the local wild birds will probably be by far the longest. It will furnish material for several general lessons. For one such lesson, separate the water birds, the marsh birds, and the land birds from one another. In all these lessons the class should be the active factor. The teacher should write on the

board at their dictation, putting down nothing that the better-informed members of the class can not agree upon, but at the same time saving the class from error by refusing to put down that which she knows or suspects to be erroneous. In another lesson place the following headings on the board: "Birds to be seen here at all or nearly all times of the year;" "Birds here in winter only;" "Birds here in spring and summer only." Let the class lead. It is not to be supposed that a list can be drawn up by the pupils that will compare in completeness with those given here, but as far as it goes it should represent their actual observations, verified by the teacher. The complete lists are not to be shown to the children at all.

After this general work is done, begin a careful study of the habits of the "pestiferous English sparrow." Get the children to suggest questions of their own to be answered by observation. Such of the following as they do not think of, ask them, and do not accept answers which are the result of hasty and careless observation.

#### QUESTIONS ON ENGLISH SPARROW.

(Adapted from Needham Elementary Zoology.)

1. By what means do you distinguish between (a) the male (b) the female, and (c) the young?
2. Is the sparrow solitary or social in its habits?
3. What kind of voice has it? Can it properly be said to "sing?" Has it different notes for different occasions, and can you discover what any of its notes mean?
4. Can it hear well?
5. Is its sight as keen as your own?
6. What does it eat? It was imported in the hope that it would rid the country of certain insect pests. Do you find it eating insects at all?
7. How do sparrows behave toward other kinds of birds?
8. What kind of a nest does the sparrow build? At what season? Out of what materials? (Keep a list of the materials used.) How put together? What are favorite locations?
9. How many eggs are laid in the nest? How long are these in hatching? How long before the little birds leave the nest? What do the fledglings eat? How do they get their food? Is more than one brood reared each season by a single pair?
10. What are the natural enemies of sparrows?
11. How many other kinds of birds nest in Oakland? If there were no English sparrows here, would there be fewer or more birds of other kinds nesting in town, or the same number?

A FEW FACTS ABOUT ENGLISH SPARROWS.

English sparrows were introduced into the United States about 1850, and have since overspread the whole country. It is the only bird to be found in many of our cities and towns.

"English sparrows are responsible for much decrease among certain of our native birds, especially the most desirable species about our cities and towns. This is the great obstacle that completely blocks the way of doing anything for our native birds. If we put up bird boxes, plant and procure trees for shelter and nesting places, provide food and water, the sparrows will 'mob' any bluebird, wren, martin or swallow, drive off, break up the nests and devour the eggs of our robins, cat-birds, song sparrows, vireos, and all our trouble will result in increasing the numbers of this 'ruffian in feathers,' a bird 'too pestiferous to mention.' It has been computed that in ten years a single pair of sparrows might increase to 275, 716, 983, 698. What are we to do with this enemy of our valuable native birds? So many differences of opinion and so many delicate points of morals and pedagogy are involved in answering this question that all we can say is, let every child study and observe the facts, and with the permission of parents do everything possible to exterminate the sparrow about the premises and neighborhood. It was a dark day for the birds, as well as for the people of this country, when the English sparrow was introduced. If, instead, a general and well concerted movement had been organized to protect our native species and give them a fair chance to do the work of insect destruction, for which our natural conditions had developed them, the country might have been a long way on the road to becoming a paradise."—C. F. Hodge, "Our Common Birds," Clark University Nature Study Leaflet, Worcester, Mass.

In a foot-note Mr. Hodge goes on to say: "The English Sparrow, U. S. Dep. Agriculture, ought to be readily accessible for reference to every class in nature study. Methods of destroying sparrows that involve suffering, wounding, etc., should be avoided as far as possible. The same is true of methods which advocate destruction of 'nests, eggs, or young,' which I regret to find are favored by the Department of Agriculture. Among the many arguments against this method we may say that a nest is a sacred thing, except to collectors, and its deliberate destruction violates our finest sentiments of home and confidence. I know of cases where the people advocate the merciful extermination of sparrows out of nesting time, but will not allow a nest to be disturbed under their own roof. Recent opposition to attempts to rid Boston of the English sparrow by the destruction of 'eggs, nests, and young,' is history in point."

With us the question of the proper attitude to hold toward the sparrow, and the question of extermination, must work itself out in some natural way. Below the Fifth Grade it would

probably be best to study the bird as a neighbor, and get the children interested in it for its own sake. In no class would it be well to begin by disparaging the little tramp. From the Fifth up, let the children study the bird for themselves, as suggested by Mr. Hodge, draw their own conclusions, and then discuss the matter of extermination. Some people advocate pulling down the nests as fast as they are made, before any eggs have been deposited, thus keeping the parents too busy building new nests to do any mischief or raise any young. In my own opinion the best way in which to approach the matter is to encourage the children to look for and to watch the native songsters until they come to want, out of appreciation for the native birds, to see their own territory restored to them, and the interloper routed by any means that are not cruel.

#### STUDY OF A LIVE SPECIMEN.

Talk with the class about the philosophy of bird-trapping in general. When is it right to trap birds? Only for the sake of learning something about them without injuring them, or if you think you can make them happier in captivity than they are free. The chances for this are very slim, unless you take the bird young and tame it systematically. Even if you do this, you should always hold yourself ready to let a bird go that is manifestly unhappy in captivity. See what the class think of the idea of "borrowing" a sparrow for a day for the sake of closer inspection. Supposing a trap is set and males and females both caught, which should we keep for the lesson? The children will at once say that the male is the one to keep, as the mother bird may have young who need her. Following are some points which might be brought out with the live bird in the room:

1. Note the shape of its body, the pointed bill to cleave the air, the smooth retreating lines made by the plumage.

2. Note the shape and attachment of the wings. Note that there are three principal joints to the wing; that these show even when the wing is extended. Would the wings be more or less useful if attached lower down on each side?

3. How do the wings differ in their motions from those of the butterfly? How are they folded up when not in use?

4. Note the shape and position of the legs; the zigzag position of the three principal joints. With the bird in hand, place the feet in the perching position on one finger, and note how the toes automatically close and open when the body is lowered toward the finger, or raised away from it.

5. The action of the legs. Does the sparrow walk? Slip a wide rubber band over the wings, and note how the bird gets about when using its legs alone. Do sparrows do the same when at liberty?

6. Respiration. Note what parts of the body visibly expand and contract in breathing.

7. The eyes. What position do the eyelids take when wide open, *i. e.*, are there any "corners" to the sparrow's eye? How many movable eyelids are there? Trace the corresponding parts in our own eyes. Make out black pupil and brown iris. Shade the bird's eyes a moment from the light and see the pupil expand, contracting again when the light strikes it.

(*Note.*—Of the foregoing, bring out all or fewer, according to the age and the numbers in the class. Many of the points here suggested could be brought out better by means of a chicken or a tame pigeon.)

8. Before liberating the sparrow note carefully the coloration of the plumage on different parts of the body. When this ground has been covered close the windows and release the sparrow. As he flies about the room note the action of wings and tail. How is the tail held during perching? starting? stopping suddenly? What motion does the bird make just before he flies? Now open several windows and release the prisoner.

*Further points.*—With another bird on another occasion (preferably a pigeon) other features may be looked into :

1. The bird's *bill*. For what is the bill of the pigeon specially fitted by shape and structure? That of the chicken? Of the sparrow?
2. The *nostrils*. Compare with ours. Compare the nostrils of any two birds which we have examined.
3. The *ear*. Note absence of any external sign. The openwork character of the feathers over it. Why?
4. The *foot*. For what especially fitted? Scales on shank.

It is well to direct the children's observations of birds they see in their garden. They should have definite things to look for or their observations will be indefinite. A few suggestions are here given :

1. Where are the birds seen? In the tree, bush, or on the ground?
2. How large was the bird? As large as a sparrow or a robin?
3. Is the body long; short; slender; plump?
4. Is the tail long or short, square, forked or rounded at the tip?
5. Are the wings round or pointed (in flight)?
6. Is the bill long, wide, hooked, stout, with lobes, and what color is it?
7. Are the legs long or short?
8. Are the toes webbed? How do they turn?
9. Does the bird have a crest?
10. Are the colors bright or dull?
11. What markings on the head; breast; wing; tail, and back?
12. Does the bird walk, or hop?
13. Does it prefer to perch on the trunk, limb, treetop, or dead twig, etc.?

14. Does it sit erect, crouched, lengthwise of the limb (night-hawk) ?

15. Is the flight direct, undulatory, heavy, fluttering, etc.?

16. Has the bird a restless, active, quiet, stupid, shy, tame, noisy, or silent disposition ?

17. Does the bird feed on seeds, berries, or insects from the ground, tree trunk, or leaves ?

18. Is the song long or short, a twitter, trill, chirp, hoot, or scream ?

(Some children are excellent mimics and this subject may well be emphasized. Far too little attention is now being given to developing the quick appreciation of the sounds in nature.)

19. Is the nest built on the ground, in low bushes, in trees, holes, on limbs or twigs ?

20. Is it saddled, pensile, in a fork, etc.?

21. Of what materials is it made ? Grass, moss, feathers, hair, twigs, etc.?

22. What color are the eggs ? How many in the nest ?

23. Study the disposition and training of young birds.

#### BIRDS HERE ALL YEAR.

Anna's Hummingbird, Barn Owl, Bluejay, Brewer's Blackbird, Burrowing Owl, Bushtit, Butcherbird, California Towhee, English Sparrow, Flicker, Goldfinch, Housefinch, Meadow-lark, Redtailed Hawk, Redwinged Blackbird, Song-Sparrow, Spurred Towhee, Titmouse, Vigor's Wren, Whitecrowned Sparrow (Gambel's), Wren-tit, Hutton's Vireo.

#### HERE IN WINTER ONLY.

Audubon's Warbler, Dwarf Hermit Thrush, Golden-crowned Kinglet, Golden-crowned Sparrow, Junco (Snowbird), Nuthatch, Pine Siskin, Pipit, Redbreasted Sapsucker, Robin, Ruby-crowned Kinglet, Townsend's Sparrow, Varied Thrush.

#### HAVING LOCAL MIGRATIONS.

Bluebird, California Woodpecker, Quail, Gairdner's Woodpecker, Say's Phoebe, Screechowl, Sparrowhawk.

#### HERE FOR NESTING ONLY.

Allen's Hummer, Barn Swallow, Black Phoebe, Chipping Sparrow, Cliff Swallow, Grosbeak, House Wren, Lark Sparrow, Lazuli Bunting, Mourning Dove, Oriole, Rufous Hummingbird, Quail, Russet-backed Thrush, Screechowl, Warbling Vireo, Western Flycatcher, Yellow Warbler.

NESTING-TIME, BY MONTHS.

*January*—English Sparrow.

*March*—Allen's Hummingbird, Anna's Hummingbird, Barn Owl, Bushtit, Redtailed Hawk, Rufous Hummingbird, Titmouse.

*April, first half*—Bluejay, Burrowing Owl, Butcherbird, Goldfinch, Screechowl, Song-sparrow, Sparrowhawk, Whitecrowned Sparrow.

*April, last half*—Black Pewee, Brewer's Blackbird, California Towhee, Chipping Sparrow, Flicker, Housefinch, Lark-sparrow, Lutescent Warbler, Oriole, Quail, Redwinged Blackbird, Spurred Towhee, Warbling Vireo, Western Flycatcher.

*May, first half*—Barn Swallow, Cliff Swallow, Grosbeak, Lazuli Bunting, Meadow-lark.

*May, last half*—Mourning Dove, Russet-backed Thrush, Spurred Towhee, Yellow Warbler.

TOAD.

The common toad has been selected for study for various reasons. (1) The life history is extremely interesting; (2) the wonderful changes passed through in the development of the toad are so rapid that it may be watched from beginning to end in the school room; (3) toads are everywhere about us, so can easily be found for school work; (4) they are not hard to keep in comfort; (5) they are of the greatest assistance to us in destroying pests; (6) they are a much abused animal, due probably to a lack of knowledge that has been brought about through early superstitions that have only aroused a feeling of repugnance and fear. Through the study of the interesting life from egg to adult we shall certainly awaken a sympathy for this creature and the harmless, helpful side will be known; for, "where sympathy is, cruelty is impossible."

LIFE HISTORY OF THE TOAD.

Toads' eggs are found in shallow water, usually among water weeds near the shore. They are about the size of a good-sized shot, black on one side. These eggs are laid in single rows in a transparent jelly. This string of eggs usually winds about grasses or weeds in the stream and can thus be distinguished from the eggs of frogs, which are laid in irregular masses of jelly, clinging to some water plant, or from the salamander or water-dog eggs which are laid in thick pear-shaped clumps of jelly fastened firmly to some twig or water plant. When the eggs are first laid they are ejected from the oviducts in four strings at once. The eggs lie almost touching one another in a string of jelly scarcely thicker than the egg itself, but after the strings are in the water the gelatinous envelope begins to swell and the eggs are separated by nearly equal spaces in the string. While the eggs are being laid they are fertilized in the water. It has been estimated by actually counting the eggs of several females, that she will lay about 8,000 eggs; one

nest contained 11,000 eggs, and if put into one string would measure 93 feet. The eggs increase in size rapidly and in about two weeks the tadpoles are clearly seen in the jelly. It has changed from the rounded black speck, with its slightly flattened pole, to a gradually lengthening dull black form which wriggles about much during the later days within the jelly. Gradually the jelly mass is broken up and our tadpoles swim about in the water. If we will look carefully at them we will see delicate thread-like frills on each side of the head. These are the gills by means of which they breathe the air in the water, just as a fish does. These are soon absorbed and their work is done by gill fringes. The tadpole as yet has no eyes nor mouth but is provided with a small sucker on the lower side of the head, which it uses to cling firmly to some stem or stone in the water. They do not swim about very much during these first days, but gradually the mouth appears and they begin to eat. The food consists of the microscopic plants found in the water and perhaps of tiny animals like entomostraca and infusoria. The eyes and nostrils appear; the plump body is more clearly separated from the tail and the gill fringes are never seen for they are covered by flaps of skin which grow over them; these are first free at the hinder margin, allowing the water to pass over them. Soon the flap over the right gill unites with the skin of the body and the left gill flap is partially closed. The tadpole at first spends most of the time under the water for he does not need to come up to breathe, but now that the gills are being covered and lungs are developing within the body he must often come to the surface and we see him taking in great mouthfuls of air. By the time the hind legs appear the tadpole is breathing with lungs and gills. Tiny little buds begin to grow on each side of the tail and gradually we find these buds developing into a pair of tiny legs. The front legs are slow to make their appearance, for they must be pushed from under the old gill flaps. All this time the tail has been used for swimming, but as the legs grow and the animal requires more and more to breathe at the surface the need of a tail grows less, and we find the tail growing shorter and paler. At no time do we find the tail imperfect. The skin is not broken, but it gradually grows smaller and smaller until it is all absorbed into the body. Is this not a far better and more economical way than to drop the tail off? The legs are growing larger and stronger. The mouth, which at first was a tiny round sucking mouth far under the chin, now comes up in front of the head and is wide. The eyes are not the stupid looking great round eyes of the tadpole, but stand up on top of the head and they can now be closed. Often our little toad will crawl up on the stems of water plants and sit for hours out of the water. It looks quite like its mother, only it has a very smooth skin instead of being covered with warts, and is no bigger than the end of your finger.

For some days the tiny toad will sit and dream among the cool

weeds on the bank. He goes less and less into the water and finally the longing to know what the world is like drives him forth, away from the pool where he has passed his tadpole days. The world he now goes out into is hot and dry. He must hide away in the grass and damp, cool holes in the earth or the sun will dry him up. He can no longer plash in the cool water and cling to the damp water weeds when the air is heavy and warm. He is a toad now and must behave as toads behave. His skin grows thick and warty but is kept moist. If we watch the skin under his throat we shall see it rise and fall regularly. We must account for this as it always attracts children's attention. The adult toads, frogs, salamanders, etc., have rudimentary ribs, extending but little beyond the backbone, so they cannot breathe as we do by expanding and contracting the ribs and thus enlarging or contracting the lung cavity. They fill the mouth with air by lowering the floor of the mouth. The nostrils are then closed by valves and they force the air into the lungs while the glottis is closed by the pressure. It is exactly the same thing we do in swallowing water. Much of the breathing is done through the skin and for this reason the skin must be kept moist. This accounts for many of the habits of these animals.

We saw our tadpole eating soft water plants, biting off tender bits with his bone-like lips, for the tadpole has no teeth. Now that our toad is out of the water he will eat nothing but animal food and he is so particular that he wants his food fresh, alive. He will eat anything that creeps or crawls or flies that is small enough for him to swallow and comes within reach of his strange tongue, which is not fastened in the toad's throat as our tongue is but is fastened to the front of the lower jaw so the free end hangs down in his throat. This is much better for the use he makes of it. If we try to stick our tongue out we find it will not reach very far, but a toad throws his whole tongue out of his mouth and, as it is easily stretched, can reach a long distance. He has a sticky secretion on his tongue that holds the insect when it is touched just as a sticky fly-paper will hold a fly. The toad draws his tongue in again and the insect sticks to the end and is carried into the mouth. The boy or girl who sees this will have to look sharply, for it is all over like a flash. A flash of the tongue, the fly disappears, a gulp of the throat and all is over.

I have told you that the toad eats anything that creeps, crawls or flies, and this is true. Caterpillar, fly, spider, centipede or millipede, slug, sow bug, hornet or bee, ants, cockroaches, beetles, are alike to him. When an earthworm is given to the toad it proves too much to be swallowed at once and the toad uses his front feet to push the worm in. The wonderful assistance the toad is to us can only be appreciated after we have studied the life and have seen the great number of insects he destroys. One observer reports that a single toad ate 24 caterpillars in ten minutes, and 35 celery worms in three hours, estimating that a

toad will destroy 10,000 insects and worms in a summer. At night or on cool summer evenings just at sunset the toads come from their hiding places and heavily hop about in search of food. They seem to take the same direction each night. They may be found wherever insect food is, by the river, in field or in the garden, and often we find them in large numbers under electric lights. Toads are supposed to live for a long time. One toad was known to have lived 36 years, and then was a cidentally killed. They may be supposed to live from 10 to 13 years.

#### MOULTING AND HIBERNATING.

We often find a toad looking fresher and brighter in color than the other toads. This is because one toad has recently shed or molted his skin. We have seen our salamanders and snakes shed their skins and the toad does much as they. His skin splits and he gradually pulls it off. Many say that he swallows his skin. Let us try and see one while he is shedding. The new skin forms under the old before it is ready to come off.

The color of the toad is of great interest to us for it tells us much about the way he takes care of himself. As we see him bunched up in his hole he looks exactly like a clod of dirt. His color hides him from a bird or snake which might pounce upon or devour him. It not only protects him from his enemies but it acts as a kind of trap, for flies and other insects wander about close to him, thinking him but a clod and therefore harmless, when suddenly they find themselves snapped up and swallowed.

When the cold days of winter or the dry hot summer come we do not see toads about commonly. They seem to disappear as by magic. They literally disappear in the earth. They go into a long sleep and almost seem dead, for they are coldblooded animals and they get stupid and inactive. They find some safe sheltered place to sleep away the months and often in plowing and digging in the ground we come upon them.

It is interesting to see how toads bury themselves in the ground. They find soft earth and begin to dig with their hind feet, and as they move the dirt out the body is pushed backward by the front feet. The soft damp earth falls over the toad as he sinks further into the ground and one can scarcely see where he has disappeared. When he has gone down far enough he moves around and makes a small cell little larger than his own body, and in this he draws himself up, closes his eyes, rests his head upon his hands and sleeps until the warm spring days awaken him.

When the young toad that we have watched develop from the tadpole has spent two or three winters sleeping he knows that it is time for him to go back to the pond. He is filled with a strange new longing and his throat swells with song. All night in the moonlight his

voice may be heard, deep and full of music for those who hear with the heart. The mating time has come. Eggs are again hung upon the dank grasses in the shallow, quiet pools and the life cycle has been completed.

*Enemies.*—What becomes of all the tadpoles? In the early spring we find every pool filled with wiggling, squirming tadpoles. The hot days come and dry up our little street pools and we find tadpoles dying by the thousands. Beside this they have many enemies which delight in the soft, plump tadpoles and feed upon them eagerly. These are the salamanders, turtles, water beetles, young dragonflies, birds and many other water animals. The grown toads are destroyed in great number by the hot sun. They are caught out in a dry, hot place and perish. Many are destroyed at night, when they leave their holes and come out to enjoy the cool evening, by being stepped upon by men and cattle or run over by carriages. Birds, hawks and owls destroy a great many toads. When the young are just leaving the water and traveling from the pools many are destroyed by hens, ducks and guinea fowls. Snakes also feed upon toads. The small boy may be looked on as one of the most serious enemies of our toads.

#### SECRECTIONS OF TOADS.

When we pick toads up or handle them roughly or disturb them they eject an acrid fluid from the anus and often a milky liquid from the warty glands of the skin. This secretion is harmless when applied to the skin but often gives much pain if it gets into the blood or the eye. This is undoubtedly the basis for the belief that the toad is venomous. This fluid protects toads from many would-be enemies, as dogs and cats show decided signs of distress when they have picked a toad up. Saliva flows freely and for some time the animal is conscious of the annoyance and soon learns his lesson.

#### SUPERSTITIONS.

We find many examples in early literature of odd superstitions about common toads. They were considered as venomous, as possessing remarkable medicinal virtues — as having within its head the priceless toadstone. It was called "the most deformed and hideous of all animals"; hence it must be venomous. Pliny writes of the venomous toads and frogs which live both on land and in the water. Aelian speaks of the breath or glance of the toad as fatal. Shakespere speaks of the ugly and venomous toad.

In the "Wonders of Nature," a translation of Pliny, we are told of the toadstone. "There is found in the heads of old and great *toades* a stone which they call *borax* or *stolon*; it is most commonly found in the head of a *hee toade*, of power to repulse poisons." Lyly says that the "foule toad hath a faire stone in its head."

It is interesting to see the bits of skepticism which creep in and we

find Tolsell, after a long discourse on the way it was said to be obtained and the cures claimed for it, closing by saying: "Therefore they being in sundry opinions, the hearing whereof might confound the reader, I will refer him for his satisfaction unto a toade which hee may easily every day kill; and if the stone be found there in substance then is the question at an end." How tactfully treated!

Pliny tells us that the toad "yields many good things medicinable." Dried toads were believed to prevent and cure nose-bleeding. English nobles bound dried toads upon their knees as a cure for gout. Toads played an important part in the magic of the early centuries. The magicians found in the toad the climax for their mysterious charms. Beside these superstitions we have the very common belief that handling toads will cause warts to grow; that killing toads will make the cow's milk bloody; that a toad's breath will cause convulsions in children. A toad in a newly-dug well will ensure an unfailing supply of water, and toads in a cellar will bring prosperity to the family.

One of the strangest superstitions about our toad is that he can live without air or food shut away within a solid rock or tree. This must mean that a toad has lived within this rock for thousands of years without food or air. Some experiments have been made to prove this statement. Three toads were put in sealed boxes of plaster and at the end of eighteen months one toad was dead. Again an experiment was tried in which the boxes were submerged in water and the toad soon died. Toads confined in cavities of sandstone and buried three feet in the ground were found dead at the end of thirteen months, and those confined in limestone were found dead before the end of two years. This seems to throw some doubt upon the stories of finding them in solid rock while blasting in quarries. It would be easy to find a toad snuggled in some crack in the rock where he had crawled to pass the hot hours of the day. It would be well to look into this question.

Another rather common belief among us is that small toads rain down. After an early shower the whole country will be swarming with small toads. The dampness has but brought them from their hiding places. Often the toads migrate from one drying pool to a larger one at some distance and at such periods are seen in great numbers, often believed some miraculous visitation.

#### WAY TO KEEP TOADS.

When the eggs are brought in they should be placed in some shallow jar or aquarium with broad surface exposure. The water should be shallow, for when we find the eggs in streams they are never in deep pools. The water must be kept fresh, and this is easily done by having a growing plant of some kind in the jar. Great care should be taken that the jar is not overcrowded, for then all the young will die. The food will be supplied by green pond scum, duckweed, water fern, chick-

weed *et al.*, which will grow in the jar. Later they will also eat bits of meat and if not well provided will eat one another. Care must be taken in changing water, for sudden changes of temperature will kill the young tadpoles.

After the tadpoles get their legs and leave the water they must be provided with stones on which to rest out of water. They also require animal food, such as flies, small moths, worms, *et al.* It is well to bring in from the streams occasionally a jar of brook water and a stone covered with plants, thus introducing fresh and natural food. Bring in at times a few tadpoles from the pool to show the children the differences which arise from changed conditions of life.

#### QUESTIONS AND SUGGESTIONS.

Can you discover any differences between the appearance and development of the tadpole of the frog and toad ?

What is the shape of the tadpole's tail ? Compare it with the tail of a fish, salamander, and an oar ? Can you see any reason for this shape ?

When do the eyes appear ? What color ? Do they wink ? When do they get eyelids ! How does a fullgrown toad wink ?

Have tadpoles holes for a nose ? Look at a fullgrown toad.

How do tadpoles eat ? Shape of mouth. Have they any teeth (thickened lips) ? Do they prefer animal (entomostraca and infusoria) or plant food ?

What pair of legs appear first ?

Which front leg has the hardest time getting out ? Why ? (Must come from the gill slit ?)

What becomes of the tail ? Very careful observation will be necessary with this work to overcome the idea that they drop the tail. Children must see that the tail gradually grows smaller and is absorbed into the body as the great changes are being made. Cut off some of the tadpoles' tails if necessary to disprove the story of their growing new tails and the old tails living for nine days after being cut from the body.

How do tadpoles breathe ? Compare adult with turtle, lizard, frog, *et al.*

Of what use are tadpoles to us in keeping our aquarium clean ? Compare one where tadpoles have acted as scavengers and another where no tadpoles have been kept.

Keep a careful note of date of egg-laying, hatching, appearance of hind legs, fore legs, disappearance of tail, leaving of water, *et al.*

What enemies have the young tadpole ? What enemies has the fullgrown toad ?

Do you know anything that will eat toad eggs ?

Watch adult toads to see what they feed upon. Sink box in ground ; keep it cool and wet ; put in food that will attract insects

(better not sweets, for these attract bees and this is often a sorrow to the toad as well as a wanton destruction of a helpful insect). Note number and variety of insects the toad will destroy. Are they our friends or enemies?

How do adult toads use their front feet in feeding? Compare the hind legs with those of the frog, grasshopper, rabbit, *et al.* Compare the frog and toad, as to the shape of body; skin; shape of head; legs; length of hind legs; adaptation to use; webs, *et al.*

Where do toads stay in daytime?

When do they sing? Why do they sing?

Count the number of eggs laid by one pair in school-room.

Weigh the toad before and after laying eggs.

When do toads hibernate?

## SPIDERS

### Our Common Spiders

[Read at State Teachers' Association, December, 1900.]

It is with delight that I shall spend a few minutes with you in talking of some of the most beautiful, the most ingenious little creatures in the wonderful animal world—spiders. Indeed, what could be a more fitting subject, since we see all about us their airy wonder-work glistening in the sunshine. These tiny creatures find no spot too grand nor none too lowly for their dwellings. Where may we turn without seeing traces of their glittering silk? In the high, waving tree tops, in the curl of a leaf, in the crack and cranny of the bark; in low shrubs, among the flowers, upon the grass, scampering about over the ground, snuggled under stones, in deep, dark passage ways in the earth, in the water, yes, even

“Sailing mid the golden air,  
In skiffs of yielding gossamere”—(*Hogg.*)

they certainly are everywhere.

The most casual observer of their spinning work is lost in wondering admiration, and the coloring of some of our commonest forms will delight the most æsthetic.

Ignorant tongues, alas, have turned against these harmless creatures, and much effort must now be spent in trying to obliterate the hideous superstitions that have been handed down from age to age, by showing the marvelous, the beautiful, the *true* side of their life.

They are common, yes; shall this perhaps be given as our excuse for knowing them so little? Shall we forever look to far away lands and strange unknown creatures to satisfy our interest? Were these dainty, swinging wheels less common; were they to be seen only in some

remote corner of the earth, no praise would be too lavish, no study too fatiguing, no effort too great for us to make if we could but catch a glimpse of them. But since they are on every bush, in every fence corner, we forget to look at them.

The history of a spider's life is a story of life's joys and its struggles. From the moment we are fortunate enough to find a soft floss cocoon carefully hidden near some mother's net, holding its wealth of daintily tinted, pearly eggs, our delight begins. The warm sun brings to life a wonderful mass of tiny babies, each wrapped in a case of thin membrane that makes it hard for the babe to make any movements. He cannot spin nor dream of catching his food, but there is little need that he should, for carefully sheltered within his silken home he may safely wait and kick off his odd little baby clothes. On some mild day a humming bird, looking about narrowly for some silken threads with which to build her home, darts down and savagely pulls at our little floss ball. Instantly our babes go dancing down on infinitely delicate lines, scattered far and near. Look for the quaint little folk among the leaves and one may find as many varying dispositions as he chooses to study. Here are the daring spirits whose strength is far beyond that of their brothers. They set out at once on voyages of discovery, swinging out on their silken threads, often letting go their hold to sail off through the air like tiny balloons—off to seek new homes. The greater number of the nest are ready to follow their pioneers, for there is an inborn spirit which seems to drive these restless little creatures away from the nest, forcing them to scatter for protection's sake. They have also within them a spirit which urges them to climb higher, and here closely huddling under a sheltering leaf our brood may "snuggle" for many days, a ball of squirming legs, heads, eyes, bodies, before they break up and separate forever. The first webs are tiny wheels, only about the size of a penny, and the threads are too weak to hold a fly. Now, alas, the tragedies are many, for our helpless little ones are easy prey to all enemies; many starve to death, and the weaker are often devoured by their stronger brothers. In fact, if two or three out of our brood live through the early hardships we are doing well. The growth is slow, and our spider must struggle out of her leathery skin nine times during her life. Two or three days before she undergoes this serious change she spins herself a shelter, clings to the silk with her claws and waits until the skin splits along the sides, when she draws the legs out, allowing the body to hang downward. When all her legs are free she clings to the web and draws the body out, and spinning out a thread she drops her legs, leaving them dangling in the air. She is utterly exhausted, and hangs thus for an hour or more when she crawls slowly, weakly away to some shelter where for some two days she remains motionless. When our spider is full grown, usually requiring two years, the love-making time is filled with fascination, for our brilliantly

dressed wooers have odd ways of attracting their mates. Our merry little jumping spiders dance wildly, striking the most dramatic postures before the object of their devotion, who is often hard to please and is in no way backward in showing her displeasure. Our queens of the web have little patience with the weaker sex and will often capture an unwary suitor, devour him and cast his dry body out of her net, turning perhaps at once to a new suitor with more favor. The last chapters of our story are filled with incidents of the most tender, most devoted motherhood. With the utmost care the cocoon is spun about the eggs. They are hidden away with great ingenuity and maternal devotion often binds a mother to her cocoon till death claims her. The mysteries are many that await us if we will but keep our eyes open, ready to see and to understand. It is that we may be in better condition to take up this work that I shall say a few words about the principal groups of spiders. We want to gain a working basis through this glimpse at typical forms, so that in our outdoor work we shall have something to guide our observations. We will be glad to have some help in grouping our data correctly, but in this attempt at classification let us not turn back to the older tables for classifying spiders and attempt to give these dry facts to our children. It is not important that one group of spiders has a greater space between the side eyes and the margin of the head than another group. Yet this kind of minute, dull work is being done in some of our best schools. I take a decided stand against this kind of work. It may be said for it that it teaches children to use the microscope and to interpret what they see there. Yes, but this should come later. If for our own use we need a table for classification use it, and for this purpose I refer you to Comstock's Manual.

But, greatly to be preferred for our work is the classification given us by Henry C. McCook in the first volume of his work on "American Spiders and their Spinning Work." Here is a grouping based upon web-making characteristics:

Key to Spiders.  
Class Arachnida.  
Order Araneæ.

I. First Division—Sedentary Spiders.

- Tribe 1. Orbitalariæ, Orbweavers.  
" 2. Retitelariæ, Lineweavers.  
" 3. Tubitelariæ, Tubeweavers.  
" 4. Territelariæ, Tunnelweavers.

II. Second Division—Wandering Spiders.

- Tribe 5. Citigradæ, Citigrades (running spiders).  
" 6. Laterigradæ, Laterigrades (crab spiders).  
" 7. Saltigradæ, Saltgrades (jumping spiders).

By this grouping we see that all our spiders are classed under two great heads according to the life habits, that is according to the inclination of the spider to build for herself a net, a nest where she remains quietly most of the time; or on the other hand to build no permanent home, but to spend the greater part of her life wandering about after food, spinning silk only as a drop line, or at cocooning time.

#### ORB WEAVERES.

Turning to our first tribe we at once find ourselves among the supreme spinners—the spinners that make the spider world a delight and mystery to us. This group includes all spiders which spin regular oval webs in all their varying forms. First these orbs may be divided into two great groups, those that are swung horizontally and those that are swung vertically. Among the latter we find the full orb of our common *Epira*.

The members of this great tribe are usually plump spiders; the abdomen, indeed, is often nearly spherical, or it may be thrown up into a number of odd elevations, giving the spider a most grotesque appearance.

The gay, sun-loving butterflies are far more brilliant in their coloring than their somber cousins, the night moths, and so it is with our spiders. Those that love the sun and the flowers are brilliant in color, while the ground-loving forms that prowl about at night, conceal themselves beneath a cloak of somber hue. Our orb-weaving garden spiders certainly belong to the former class, as their colors are often of the brightest.

The net of our orb-weaver is made up of many parts. We first get an outer framework of intersecting lines, one of which is usually much stronger than the others, this being the bridge line that is first laid in and to which the net is hung. One line is stretched across the space between this intersecting framework in such a way that it shall pass through the center of the orb, and from this central point, in an irregular way, the radiating lines are put in. Constant care, however, is taken to so place the lines that the central point may not be pulled out of its position. The radiating lines are firmly stayed in the center and the central or hub portion is built according to the habit of the spider. A spiral line is now placed around the radii; this is the temporary scaffolding on which the spider will walk while laying in the fine, closely coiled spiral of her finished web. Thus far all the silk used has been dry, inelastic silk. From the outer edge of the orb the spider proceeds to lay in the most important part of the web, the sticky, elastic spiral that will yield, yet cling the firmer to the struggling prey.

Off to one side of this net, usually just a little above, the spider makes for herself a sheltering nest in which she awaits her prey with head looking out and feet ever upon the strong trap line leading to her net, ready to respond to the slightest motion which tells of a captured

insect. These nests are often of most exquisite form, being made of prettily curled leaves or flowers fastened together and lined with the whitest of silk.

Near this nest the mother hangs her pretty cocoon, usually a soft, flossy ball, hidden carefully among the leaves.

The variety in form of these cocoons and the ingenuity shown in the way they are hidden offers a field for study that is of great interest.

#### RETITELARIÆ.

(Line weavers, cobweb weavers.)

These are small, timid, slender-legged spiders spinning webs that are often of great size, and here the tiny creature clings with her back downward or hiding away in a sheltering crack or corner. The lack of brilliantly colored hairs or scales makes this tiny inhabitant of our homes a plain, modest, seldom-seen spider, though her work is one of the greatest trials a careful housewife has. These webs are usually flat or curved sheets of web, under which the spider hangs and which are supported by threads running in all directions to neighboring objects, often forming a dense mass of irregular lines above the web, which help in entangling prey and making it fall to the flat web below where the spider awaits. This maze of web does not delight us as does the wonderful orb web, for it hangs a shapeless mesh in the corners of our house. At first this is pure white and brilliant, but dust easily collects upon it, making the unsightly object with which we are familiar, in deserted houses, attics and cellars.

Though these house cobweb-weavers are most familiar to us, many species live out of doors, stretching their webs upon bushes, in hedges or in fence corners, many even having small funnel-shaped tubes leading off to the sheltering corner where the spider lies in wait for her prey. They can always be distinguished from the true funnel-weaver that we shall speak of later, for they run on the under side of their web with their back down.

To the upper end of this snare of intersecting lines the spider adds threads to strengthen it, and here she hangs her cocoons, often as many as five. They are usually white, and are oblong, flask-shaped or balls of floss. When the young hatch they are found clinging together in clusters for a time and then they break away, going to adjacent places at once begin to spin nets for themselves.

During incubation the mother watches unceasingly, even forgetting to feed, but as soon as the young are out she again devotes herself to eating, and dead insects lie about in great numbers.

Certainly she is a great blessing to us in destroying many of our most disagreeable pests, and should we not be generous enough to grant her a wee corner of our dwelling and indeed court her presence?

TUBITELARIÆ.

(Tube weavers, funnel weavers.)

We have little idea of the immense number of spider webs that are spun upon the ground until a foggy morning reveals to our astonished eyes wonderful fairy draperies, an almost continuous carpet of spun silk. As Thoreau so aptly said, the grass is thickly strewn with the daintiest "fairy napkins."

These sheets of silk spread upon the grass are familiar to us all, and we will remember the funnel-shaped tube which leads off from one side, where perhaps we have seen the long legs and the sharp eyes of the grizzled owner, watching for the slight movement of the prey, when out she dashes across her silken carpet to pounce upon the unwary insect and carry it away, to be eaten at leisure within her silken tube. Let any more formidable creature approach, and instantly, like a flash she scuttles off through her tube, the lower end of which opens among the grass roots, offering the best possible means of escape.

The spiders themselves are long-legged and are dark brown in color. The head part of the cephalothorax is higher than the thoracic part, and is separated distinctly from it by grooves or marks at the side. The posterior pair of spinnerets are two jointed, and are usually longer than the other pair.

The spider attaches her cocoon to a leaf, a rock, a bit of bark, and we can easily recognize it for it is a patch of closely woven silk about half an inch in length. The eggs are wrapped in a sheet of web which is covered with bits of pulverized bark, earth, or sawdust from the neighboring objects, and this in turn is enclosed within a sheet of silk.

TERRITELARIÆ.

(Tunnel-weavers.)

No tribe of spider is better known than this group, containing, as it does, the giants among spiders. We all know the dark brown, long legged, hairy tarantulas. They build no true web, but dig deep holes in the ground to live in. These holes are lined with soft satiny silk spun from the spider's spinnerets, two of which are very long and curve up at the end of the body.

These spiders spin no nets to catch their prey, but when dusk gathers they creep out of their holes and stalk about in search of food.

The jaws of this group are characteristic in the way they move up and down, while the jaws of other spiders move sideways. This accounts for their way of fighting. They rise on their four hind legs and rear up, lifting the head to a vertical position with the strong hollow fangs directed forward. As they jump forward the fangs are driven into the flesh and the violence of the shock causes the poison to go through the hollow fangs.

The members of this tribe that have attracted by far the most interest and admiration are the bright eyed, cunning workers that ingeniously conceal their hiding places with a trap door.

This door closes over the opening of the tube with the utmost accuracy. In fact, even one who knows where the nest is often finds it difficult to see it again if the door is closed. The door is held in place by a hinge of tough silk that has elasticity enough to close the door when it has been opened. The door is held firmly closed by the long palps of the spider, which fit into two small holes in the silk lining near the front edge of the door. The feet at the same time are pressed out against the tube. The hold is so firm that it is practically impossible to open the door without injuring it.

Often we find branching tubes leading off from the main tube in which the spider takes refuge when pursued within her nest. These side tubes are often provided with trap doors which effectually conceal the opening, thus offering successful retreat.

At night the door is lifted and a search for food is made.

When the young hatch from the cocoon they remain with the mother until they are old enough to set out and dig holes and set traps for themselves.

Turning now to our second great division we take up spiders which build no true nets to live in, but wander about after food.

#### CITIGRADES.

##### (Running Spiders.)

These spiders live on the ground, and anyone who has done any collecting will recognize the large, long-bodied spider often found hiding under stones and logs.

The body is longer than broad and is covered with hairs, which make the rather characteristic markings usually three longitudinal light lines on the cephalothorax and a middle stripe of various shape on the abdomen.

As these spiders depend largely upon their quickness in running they have long legs with long movable spines all over them. Many of this tribe, however, dig holes in the ground in which they shelter themselves, but never use them as a trap. Above their holes the spider builds a hollow turret of silk strengthened by bits of earth, dry leaves and twigs.

We have all seen these spiders scurrying over the grass, dragging with them a ball of dirty gray silk. This is the precious cocoon containing the pearly eggs or the newly hatched young, and the brave little mother will fight till the last rather than yield her eggs, but if she is forced to it she will run off a little way and return to gather up the cocoon when it is dropped, even stopping to gather up the various

pieces if it has been torn open. When the young come out of the cocoon they mount upon the mother's back and are carried about by her until they are strong enough to run off for themselves.

LATERIGRADÆ.

(Crab Spiders.)

Another spider we meet among our flowers in the sunshine is the interesting little spider called the crab spider from the odd way she walks, for she can run sideways or backwards more readily than forward.

She spins no web, but with her gay colors, milk white with crimson spots, rich yellow with ruddy brown patches, mottled sage green of the lichen type and other hues, she rests among the blossoms, so closely imitating them that the witless fly pauses too near her outstretched legs and instantly is pierced by the sharp teeth.

The peculiar movement in walking is due to the remarkable development of the first two pair of legs, which are long and turn outward and forward.

The last two pair of legs are short, and the short, broad body is carried near the ground. They always have a slender thread of silk after them as they crawl about, and as they pass across the grass they leave a veil of glittering silver. The French peasantry call these the "Virgin's thread."

SALTIGRADÆ.

(Jumping Spider.)

The jumping spiders live on the ground, on plants, on trees. Every motion is as quick as a flash and made with a jerk. Their bodies are broad and the angles are sharp. Their colors are often most brilliant, as much so as our humming birds or beetles. These markings are usually formed of colored hairs or scales, so are easily rubbed off and are destroyed by whetting. The legs are short and stout, being fitted for the jumping life they lead.

They spin no web, but always attach themselves by a line before they jump, making themselves safe should they by any chance miss their aim. They catch their prey by pouncing upon it. When the mother lays her eggs she spins some cross lines under bark or a leaf, and here she stays until her brood is hatched.

Their quick, jerky motion, their glittery impudent eyes, their audacious manners, indeed these spiders to us in a remarkable way, and I know of no spider that will outdo them in catching prey, in fighting, in wild love dances or in motherly devotion.

We have now touched upon the main types of spiders, and have incidentally hinted at many of the profoundest lines of study that can be at least started without young children. Spiders can be caught in

small boxes by allowing them to drop from the web into the box and quickly shutting the cover down. When they are taken for a long study it is best to give them all possible freedom. Turn many loose in the room and the great orb webs will be spun among the plants in the window or in the bright corners. If they are kept in boxes give them much air and the spiders that have room to spin will feed for you.

Line-weavers may easily be kept in the corner of the room. Tube-weavers will stretch a web for us across a box or fill a glass jar or bottle with a wonderful mass of white web.

The great running spiders, Lycosids, are perhaps best of all, for they are hardy chaps that soon become gentle enough to come and take the fly from your fingers, though nothing is more delightful than to see the boys with their own particular little jumping spider on their desk, where he struts about with his saucy head up, ready to creep up and devour any fly unfortunate enough to light near him.

Do not forget that spiders must have water to drink as well as insects to eat. Often have I found, shut up in a tight, small bottle far back in a dark, dusty corner, these poor, sun-loving sufferers clinging sorrowfully to their bit of web, and a drop of water put near them was as eagerly drank as it could have been by any human prisoner. If you capture and imprison spiders, do not forget them and learn what nature provides to make them comfortable.

The odd little ways they roll up and pretend to be dead when frightened is most interesting. The study of mimicry, of protective and aggressive coloration finds in the spider-world many objects of interest.

## BUTTERFLY

### LIFE HISTORY.

*Egg*—The eggs of Butterflies are found on the food plant upon which the caterpillar will feed after it hatches. These eggs are variously formed. Some are spherical, others conical, barrel-shaped or flattened at the poles. The surface is often delicately ribbed or with a net-work of raised lines. The color also varies for we find blue, yellow, green, brown and red eggs often prettily marked with lines of darker color or silver.

The eggs are sometimes laid singly, one upon the lower surface of a leaf near the strong midrib where it will be hidden and thus protected from enemies, or again the eggs are laid in masses or clusters on a twig. Often the delicate tints of the egg change a few days after they have been deposited and grow dark.

The time required for the hatching varies with the butterfly, some having two or three broods a summer while others have but one.

*Larva* — When it is time for the larva to hatch, the little caterpillar

bites through the thin shell and crawls out upon the leaf. Often they turn and devour the eggshell at once, thus destroying all trace of their presence.

The caterpillar's body is made up of a series of rings and is usually long and wormlike. The head is always easily found for it is hard and usually large and conical or spherical. The mouth is provided with a pair of strong teeth moving in from the side. The lower lip has a short, horny projection, through which the silk thread of the caterpillar is spun. The eyes are arranged in groups on each side just above the mouth. The first rings of the body are provided with six jointed legs or true legs. These will remain with the adult butterfly. Beside these six forelegs we find four pair of prolegs on the underside of the middle segments of the body and another pair at the end of the body. These ten legs are lost after the larval stage is passed.

The bodies of caterpillars vary greatly in their ornamentation some are smooth, others covered with stiff spines. The colors vary from dull tints, an exact mimic of the twig on which they live to the gayest of coloring, matching the brilliant flowers. Some caterpillars are social in their habits but a far greater number live solitary lives.

Caterpillars moult from four to five times before attaining full growth. Before casting the skin the caterpillar ceases eating for a few days, spins a few threads of silk upon the surface of the leaf, attaches himself firmly and remains quiet for some time. The skin splits along the back and the caterpillar crawls out with much twisting and squirming. The greatest difficulty is met with in the hard casing of the head, which often resists all rubbing and pushing for some time after the entire skin is off. This period of life varies according to the kind of butterfly studied. Our common forms remain usually one or two months.

*Pupa*—The full growth having been reached we find the heavy bodied caterpillar crawling off to some sheltered place under a fence rail, among the stems of a vine or elsewhere and after spinning a small patch of silk over the surface they cling to this with their last pair of legs, allowing the body to fall downward, curving the head up against the folded true legs. After hanging thus the skin again is moulted and we get a chrysalid. Many caterpillars are not satisfied with clinging to the button of silk; they suspend the body in a girdle of silk fastened on each side just above the middle of the body. Most chrysalids are dull in color though many are brilliant as in the case of our common milkweed butterfly. By looking carefully at the chrysalid we may see many of the organs of the future butterfly, the wings, legs, eyes, mouth, antennæ, *et al.*

This stage again varies in length according to the butterfly. Some passing through this period in a few weeks while others pass the winter thus protected waiting for the warm days of returning spring.

*Imago*— During the pupa stage the butterfly takes no food and is able to move but little. Often the colors of the wings show through the skins of the chrysalis a few days before the butterfly breaks out of the case for the last time. The skin splits away from the head and legs and slowly, weakly the body and wings are drawn out. At first the butterfly bears a close resemblance to the caterpillar for the body is long and large, the wings scarcely showing as tiny pads on the back. Remarkable is the change which now takes place. The vital fluids are forced from the body into the wings. They grow rapidly into the form they are to keep, gradually they harden in the air and the muscles are strengthened and the butterfly is ready to take flight.

*Food*— Butterflies feed upon the honeyed water from the flower cups. This is drawn up through the proboscis which is formed of two semi-cylindrical tubes, which, being brought together, interlock and form a complete tube. At the upper end of this proboscis, within the head, is a bulb-like organ which acts like a bulb-syringe and the honey flows up the tube. When the proboscis is not in use it is carried tightly curled, looking like a watch-spring.

*Wings*— Butterflies' wings are usually held erect when at rest, allowing only the underside of the wings to meet the eye. The wings are made of double thin membranes to which are attached flattened scales. These scales overlap one another as the shingles of a roof. They are often very beautiful when seen under a microscope, showing a great variety in form and color. In many butterflies these scales are especially modified and give off a distinct odor which we are able to detect in a few cases, as the cabbage butterfly.

*Difference between Moths and Butterflies*— Butterflies have a slender, threadlike anteunæ with a swelling at the end, a club-shaped anteunæ, while moths have variously shaped anteunæ, some are feather-shaped, others are prismatic with small spur at tip. All butterflies love the sunshine and fly about by day.

Butterflies are so showy that they are especially adapted to our work and are good forms to begin our first steps in grouping. They are easily recognized while on the wing and children delight in being able to call things by name. Not that this attempt at classification shall be a minute study but shall only carry butterflies to the family. We may use the following grouping :

*Classification.* 1. Brush-footed Butterflies, Nymphalidæ. These butterflies can be recognized readily by the dwarfed front pair of legs which are never used for walking but carried up against the breast. This gives them the name of Four-footed Butterflies. By far the greater number of our butterflies come within this group.

2. Blues, Coppers and Hair-streaks, Lycænidæ. These are the delicate little butterflies we find in such great numbers fluttering about damp places. The commonest color is gray blue.

3. Papilionidæ, or Swallowtails. These butterflies are striking in size and brilliant in coloring with us. They are bright yellow and black and the hind wings with a tail-like prolongation.

4. Whites and Yellows, Pierida. These butterflies are of medium size and our common cabbage-butterfly is a typical form. They are white, yellow or orange marked with black. They are common everywhere.

*Enemies*—The enemies of butterflies offer an interesting field of study. Flower spiders and birds are perhaps the commonest enemies. Observe the methods used by the flower spiders. How do butterflies protect themselves against their enemies? Experiments may be made with butterflies in the class room to learn the weights they are able to carry in flight, walking, et. al. Butterflies should be kept in the school room and fed. Its sleeping habits observed. Are butterflies bold or timid? Do they like to have other butterflies about the same flower they are feeding upon? Do butterflies fight, play or seem to be friendly? (Woodworth Nature Study Bulletin. U. C. will be found suggestive.)

## CARE OF AQUARIA.

### GENERAL HINTS.

Tadpoles and other aquatic creatures have an irresistible fascination for the average child. Whether or not the teacher has planned to take advantage of this peculiarity of the child, and have a series of lessons on pond life, she will have it to reckon with sooner or later, for some day the door will open and Johnny will appear bringing in a jar full of polliwogs—the polliwogs very crowded, hungry, and uncomfortable, Johnny smiling in anticipation of his teacher's delighted admiration. The polliwogs, whether entirely welcome or not, are there, and something must be done for their safety and comfort without undue delay. If the next nature study period is not too far distant, it would be well to leave the tadpoles just as they are till then, the teacher providing herself, in the meanwhile, with a shallow dish, or several fruit jars, and an old kitchen spoon. Then let the first lesson deal with the care of tadpoles, and with that alone. Speaking for myself, I should on no account begin by giving a lesson on the structure and activities of the tadpoles themselves as long as the latter were inadequately housed and in danger of death through suffocation, starvation, or disease from foul water. Get the children to tell what sort of place the frog or toad mother chooses to place the eggs. *Why* shallow ponds, and the still pools of creeks? *Why* not rapids, horse troughs, or deep wells? Have the children draw on the board each of the following kinds of pond as it would appear viewed in cross-section: (1) a deep pond; (2) a pond with vertical sides; (3) a deep well with little water

in it; (4) a well with the sides approaching at the top, like the sides of a fruit jar; (5) a shallow pond. Discuss, with the children, the life conditions that would prevail in nature in each of these ponds—in which there would be the best growth of tiny plants for the tadpoles to eat; in which the scantest crop; in which would there be places to rest after swimming, without going clear to the bottom? Let the class "make believe" they are polliwogs, and vote, choosing which kind of pond they prefer for a home. Now the question comes, how provide that sort of a pond (a shallow one, with gently sloping sides) for the visiting polliwogs? Very small tadpoles can be put into quart bowls; larger ones into earthenware mixing bowls, agateware basins, tin pans, or a galvanized iron or wooden tub. Wide-mouthed, straight-sided jars would do, if resting-places were provided in the shape of large stones, submerged straws, together with sprays of wandering Jew. If nothing is to be had but an ordinary fruit jar, that is better placed obliquely on its side in one of the plant boxes than standing upright. Why? However the tadpoles are housed, there should be but few in any one dish. If too many have been brought to school, some might be given away, some taken home by children who would prize them, and if there are yet too many, a few might be returned to their native pond.

#### BREATHING.

Creatures begin to need oxygen as soon as the egg begins to divide up into smaller cells. Masses of eggs, then should not be left in tall, deep jars, but should be placed in shallow dishes, and the plants which are to serve as food for the baby frogs or water dogs started.

Acquatic dwellers come into two categories as to their mode of breathing:

(1) The breathers of dry air—those which come to the top to breathe, or which carry bubbles down with them, as mosquito larvæ, water beetles, giant water bugs, ranatras, water boatmen, back-swimmers, tadpoles in later stages.

(2) The breathers of the air dissolved in water. They may have gills, internal or external, or may breathe through the skin, or by a combination of these methods. In water-dogs after metamorphosis, the pharynx is used to supplement the skin as a breathing organ. Dragonfly larvæ take water into the posterior end of the alimentary canal for the same purpose. Fishes breathe through internal gills; some insect larvæ by means of gill-like expansions of the skin on the sides of the abdomen, as the larva of the Mayfly and caddis fly. Water-dogs are born with three pairs of external gills, which they retain until metamorphosis, which may occur within the first year, or may be delayed as long as four years.

Frogs and their near relatives, while yet in the egg, acquire two structures which are to be associated with their breathing: (1) rudiments of one or two pairs of external gills; and (2) gill clefts which

put the back of the throat, or pharynx, in communication with the exterior. The young tadpole takes water in through the mouth and lets it pass out through these gill clefts, which for the frog (according to Parker) are six in number. This first set of gills may or may not (according to the species) become conspicuous. Whether they do or not, they are short-lived, for they are soon absorbed and their place taken by gill-fringes which arise, as in fishes, on each side of the gill-clefts. These second gills are never seen from the outside, because while they are forming a flap of skin grows from the front of each side of the head back over the whole gill region. For a while each flap opens freely at its hinder margin, permitting the water taken in through the mouth to pass out at each side. Soon, however, the flap on the right side unites with the skin of the abdomen. That of the left side unites for only a part of the way at first, so that the water which has bathed the gills can still pass out through a round opening on the left side. By the time the hind legs appear, the tadpole is breathing with both lungs and gills. By the time the tail is entirely absorbed and the tadpole takes to land, the gills have been also absorbed, and the tadpole breathes with lungs only. Suggestion: To ascertain where the gill-flaps open in any given specimen, put him by himself in a glass of slightly muddy water and watch to see from what point the tiny particles of mud are expelled. This takes patience, and must be done by pupils individually, as it is not suitable for a class demonstration. When nothing remains of the gill-openings but the little tube on the left side, that can easily be seen by looking down on the specimen from above. Frogs, toads, and hylas, in all stages, do part of their breathing through their skins. That is one reason why the skins of the adults must always be kept moist. The adults have no ribs, so they cannot breathe as we do, by the alternate enlargement and constriction of the chest cavity. Instead, they fill the mouth with air by depressing its floor. Closing the nostrils on the inside, by means of the tongue, they *swallow* this mouthful of air. The glottis being at this moment closed, the air goes into the lungs.

#### THE SUPPLY OF OXYGEN.

Cold water holds considerable air in solution. To demonstrate its presence to the children, heat some water fresh from the faucet in a test tube, beaker, or flask, and have them watch those first tiny bubbles, almost uniform in size, which gather on the sides, and finally rise to the surface. That they cannot be *steam* bubbles is shown by the fact that they are formed at a relatively low temperature — the glass may be held in the hand while they are forming — which is far from being true of boiling water, with its bubbles of steam.

In the first discussion with the class about the care of tadpoles, it is just as well to avoid the question of air-supply. That may be brought

up as soon as the pupils have been led to discover that the younger tadpoles breathe without coming to the surface. Then is the time to demonstrate the presence of air in water, lest the children *think* what they often *say* when questioned, that fish and tadpoles breathe *water*. Now if the tadpoles are taking oxygen away from the water, how is the water to get more air containing oxygen? How did air get into the water in the first place? Manifestly, in the absence of any more direct agency, it came in through the surface of the water which is exposed to the air. Given two dishes of water each containing (say) a quart, but one shallow and wide and the other deep and narrow, which will absorb its share of air the sooner? Suggestion: Do not ask this question in the abstract. Pour a given amount of water into a vessel of the former sort; have a pupil cut a piece of paper just the size of the exposed surface. Pour now into a dish of the latter type. Have another pupil cut paper the size of the surface now exposed. Pin both pieces up in plain sight, and discuss.

But nature has provided oxygen for its water dwellers in another way also. To demonstrate: From a pond which has stood exposed to the light of the sun for some time, gather some of the green algae, without reference to the exact kind. Put some in a tall bottle with clear sides, and stand on a sunny window sill. Soon bubbles will form upon the masses of submerged plants. Shake the bottle slightly; the bubbles will rise, thus becoming very conspicuous. Call the attention of the class to them. What you will tell the class will depend upon their age. It is sufficient to tell very young pupils that this is very pure air—the kind that water creatures like best of all—it makes them lively, and ready for fighting or for fun. It takes away that smothered feeling they have when too many of them get together in a deep place. Now the children can see that the tiny green plants serve a double purpose—they are food for the tadpole, and they also keep the air in the water pure and fresh. The children can see that if only enough green plants can be made to grow under the water of the aquarium, then the water need not be changed so long as no unusual cause operates to render the water foul, such as an accumulation of extra food, or neglect to remove dead bodies. Suggestion: Keep a culture jar for green algae, desmids, and diatoms always on hand. This should have a few dry leaves in the bottom, but no animal life except, perhaps, a few of those insects which breathe dry air. It can then stand in full sunshine all day long, and plants may be sown from it into the aquarium. Such a jar should be labeled, else its contents, apparently worthless, are liable to be thrown out. Algae are not the only plants which help to aerate the water in which they grow. The truly aquatic plants with submerged leaves are both useful in this regard and highly ornamental. In the permanent ponds in the fields northeast of Alameda several beautiful ones await transplantation. Most of these need to

have their roots in mud. When they are gathered, some of their native mud should be brought home in a tin can. This can be placed in the shape of a mound on the bottom of the aquarium, the plant's roots embedded in it, and the mud then bound down by a layer of well-washed creek sand, with a trimming of pebbles and shells, if desired. Beach sand will do if the salt is all washed out. Two of the most beautiful of the plants just mentioned are a vivid green stone wort, and a ranunculus, a near relative of the buttercup. The finely divided leaves of the latter are entirely submerged, but the yellow and white blossom is borne on a vertical stem just above the surface of the water.

#### FOOD AND FEEDING.

*Very Young Tadpoles*—Eggs of water-dogs, frogs, etc., have presumably been standing in shallow dishes in which green algae, desmids, and wandering Jew, water fern or duckweed are already growing. If so, then the food of the tadpoles awaits them. They do not begin to eat, however, for several days after hatching. According to Professor Ritter, the mouth of the water-dog "is not yet broken through when the larva escapes from the jelly mass," and "unless disturbed in some way the creatures move very little for several days after hatching." Their lack of anxiety about eating is to be accounted for by the abundance of yolk which "persists on the ventral side of the body for a considerable time after hatching." It would be interesting for the children to keep a close watch on newly hatched water-dogs, toads, etc., to see just how many days it is before any given set begins to eat; then different classes might exchange notes. When the tadpoles begin to eat it is the smallest—the one-celled green plants—which they attack first. As they themselves grow, they are able to eat tiny leaves, such as those of duckweed, and to nibble at bunches of water-fern, or at the margins of the leaves of larger plants, such as geranium. Put in a few dry leaves, as of alder, elm, or linden, and see what happens.

*The Tadpole Half Grown*.—When a frog or toad tadpole hatches, its alimentary canal is short, running in a straight line from the mouth to the anus at the base of the tail. It gradually lengthens, and by the time the tadpole has attained its full length, the intestine lies coiled like a watch-spring. In a light-colored specimen this coil may be made out just underneath the skin of the rounded abdomen, on the ventral side. It is this relatively great length of intestine which proclaims the tadpole to be a vegetable feeder. Tadpoles at the stage when the legs are just beginning to form need a great deal of green food. They will eat the thready green algae, duckweed, water-fern, chickweed, and even nibble at large leaves thrown in for them. But while the tadpole breathes by gills and eats mostly vegetable food, it is destined in time to become carnivorous, and to breathe with lungs. In both the feeding and the breathing habits, the change comes gradually. The larger

tadpoles are seen to come to the surface occasionally to eject a bubble of air, and apparently to take a fresh one in. A fly which drowns on the surface is no longer ignored, but nibbled at, and finally eaten. At this stage, the tadpoles may be given meat at intervals, (say) once in three days. Take a piece not larger than the end of one's finger, tie it by a string, and suspend so it hangs just under the surface of the water. The meat should be raw, and not salted. If put in during the morning, remove in the afternoon. Tadpoles will eat a limited quantity of bread crumbs. To a tadpole one crumb is a whole loaf. See to it that the children do not throw in more than the tadpoles can eat. Should this happen, take pains to remove the uneaten portion, because if left, it will inevitably sour and cause trouble.

*The Tadpole with Diminishing Tail.*—The children are often so completely lost in admiration of the frog or hyla tadpole whose tail is nearly or quite absorbed, that they forget that the needs of the little fellows are changing as rapidly as their physical appearance is changing. As soon as all four legs have appeared, and the tail has begun to shrink, the tadpoles should be provided with a sandy bank on which to rest between swims. They need not be taken from the aquarium at first, if it is already a shallow dish; gravel may be banked up at one side. But if the aquarium is deep, with vertical sides, a froggery must be set up at once. Get a box which is longer than wide—a macaroni box will do for small creatures. Fill it about half full of earth, and in one end sink a shallow dish for water. Plant in the earth such weeds as flourish at the sides of creeks, and keep the whole thing very moist. Wire cloth may be tacked firmly over half the box. The other half should be like a wire screen door, hinged so as to open, but arranged to hook firmly, that the frogs may not escape, to their certain death. Another good arrangement is a long, shallow box with zinc tray placed in the bottom. Half the tray may then be beach, the other half a shallow pond. For such a box a wire cover would be necessary as soon as the inmates reached the hopping stage. The natural food of the tadpole-frog is small insects, and if mosquito pupæ are available, they might be put into the pond of the froggery and allowed to hatch out there. However, the littlest of the frogs can manage small flies, and they should be fed daily with these.

*The Adult Frog.*—A permanent froggery for grown frogs should have wire screen sides as well as top, and be so roomy that the inmates will not appear cramped for space. There should be earth with growing plants in the bottom of the froggery, and a pan of water. If toads or water-dogs live there, fresh earthworms should be put in from time to time. Frogs and hylas will flourish on house flies and sow-bugs.

*Fish.*—Of fishes easily obtained here, none but the domesticated gold fish and the little stickleback of our creeks can be kept with success. For the former, prepared fish food is to be had, which, with

bread crumbs, makes the feeding problem a very simple one. Sticklebacks are hardy, but pugnacious; one to a jar is the safest arrangement, as the males, especially, are liable to fight and kill each other. (What parts of the body serve as weapons?) They are carnivorous, eating flies and other small insects dropped alive on the surface of the water. They are especially fond of very small grubs fed them in this way, of the pupæ of ants, and of the freshwater shrimps, (so-called), which live around the water-fern. They are said to like fresh beef minced very fine. They care little for bread.

*Water Snails.*—These are desirable residents of the aquarium, acting as scavengers, eating decayed leaves, roots, etc., and occasionally laying a bunch of tiny eggs embedded in transparent jelly, on the side of the glass. The snails, when they hatch, are almost microscopic, but soon become visible, crawling over the glass in all directions. There are three kinds of water snails in our creeks. Waterdogs eat adult snails, shells and all.

#### AQUATIC INSECTS.

These fall into two classes, the partially and the wholly aquatic. Examples of the class in which the young only are aquatic are: mosquito, dragon-fly, damsel-fly, May-fly, stone-fly, caddis-fly. Those permanently aquatic are: water-beetles and water-bugs. The word "bug" is used here in a technical sense, signifying the great order Hemiptera, of which the squash-bug is the best known representative. The beetles have shiny black or brown backs, with their wing-covers meeting in a straight line down the middle of the body. There are several species in the vicinity of Alameda. The small black whirligig beetles spend most of the time on the surface of the water. The water-scavengers come to the surface head first, and carry down with them a bubble of water which spreads over the under surface of the body, and gives it a silvery appearance. The predacious diving beetles come to the surface tail first, take the air in under the wings, with perhaps a tiny bubble showing at the hinder end of the body. Put some water-fern and a small earthworm in a dish in which there are several kinds of beetles, and see which kinds are interested in the one and which in the other.

*Water-bugs.*—The first to be seen on approaching is the water-strider, or skater. They are long-bodied, and seem at first sight to have but two pairs of legs; but let an unlucky fly fall on the surface of the water, and the first pair, which have been held forward, close to the head, come into play to hold the insect while the short, sharp beak searches for blood.

Another lively member of the family of true bugs is the back-swimmer. It comes to the top for air, and swims on its back, using its long hind legs as oars. Its cousin, the water-boatman, is much like

it, but smaller, while in swimming its body is not reversed. Both are winged and can fly if they choose.

There are several kinds of giant water-bugs, all sluggish, the adults winged. Like their still more sluggish cousins, the long, slim ranatras, they suck the blood of other insects. The most convenient food for all these bugs while in captivity, is house-flies, thrown on the surface of the water.

Young dragon-flies are very interesting to watch because of the peculiar method employed in catching their prey. Into a dish containing dragon-fly larvæ put mosquito wrigglers, small earthworms, or the little water shrimps. "As an unsuspecting insect swims by the masked face of the young dragon-fly, like a flash the lower lip darts forward and those two fine-toothed grasping flaps at the tip seize the insect, and carry it, as the lip folds up again, to the strong jaws of the captor." (Jenkins and Kellogg). When dragon-fly nymphs show a disposition to crawl out of the water, place twigs or grass for them to use as a ladder, and put mosquito netting over the aquarium, for they are about to transform. This transformation may take place early some morning, but there is a chance they will choose an hour during the school session in which to emerge. Just now (April) dragon-flies are "hatching" out every day in the sunny shallows of the creeks. The slender damsel-flies are the more abundant, and a dozen or so brought in now would all transform within a short time.

#### LIGHT AND HEAT.

The aquarium should not be exposed to direct sunlight for long at any one time. Checkered sunlight, such as that which comes through a row of growing plants, is good for part of the day, and entire absence of direct sunlight would be hard on the plants growing in the aquarium. The temperature of the water should not be allowed to get above 60 degrees Fahrenheit.

#### MISCELLANEOUS DATA.

(Will teachers please add to, revise, or correct, the statements given below, as experience puts new data into their hands.)

Mosquito eggs hatch in from twelve hours to several days after being laid. (Jenkins and Kellogg.)

Water-dog eggs hatch in about thirty days after being laid. (Dr. Ritter.)

Mosquitoes live from one to several weeks as larvæ, and about three days as pupæ. (Jenkins and Kellogg.)

Toad eggs hatch in about three days after being laid. The entire transformation up to the loss of the tail requires about two months. (S. H. Gage, in Cornell Leaflet.)

Frog eggs hatch.....?

Hyla eggs hatch.....?

What to feed what becomes a very practical question to the keeper of an aquarium. Accident sometimes reveals much-desired information. Will teachers please fill in the following blanks as experience brings out points not covered in the foregoing ?

#### FEED.

mosquito larvæ .....	water-boatmen.....
beetle larvæ .....	backswimmers .....
dragon-fly larvæ.....	water-striders .....
tadpoles .....	predacious diving beetles. ....
sticklebacks .....	water-scorpion beetles.....
giant water-bugs.....	whirligig beetles .....
ranatras.....	

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#### TURTLES

Turtles are usually abundant about our lakes and streams and are easily kept in a cage or aquarium. They feed on meat, tadpoles being especially liked, or angleworms. They are to be compared with lizards and snakes.

How is the hard shell used ? Can the turtle leave his shell ?

Observe his method of walking and swimming and compare with fish, frog, salamander.

Note peculiar flattening of feet and see why this is so. Do they climb ? live in water all time ? Where spend winter, study hibernation ? What is their food ? How do they eat it ( chew it or swallow whole ) ? How do they capture it ? What are their enemies ? How do they defend themselves ? Do they ever attack an enemy ? How do they breathe ? Compare with frogs, toads, salamanders and lizards. Do they close their eyes ( wink ) ? Compare with snake. Do they lay eggs ? Where ? How to they look ?

## WORMS

### SUGGESTIONS.

- Why plug up holes with leaves, et. al.? Do they eat these?
- When are castings most numerous?
- Why so abundant after rain?
- What locations most numerous?
- What is the meaning of the small heap of earth?
- How do they bore their way in the ground?
- Gather earth brought up in one night, dry, weigh and estimate amount to acre.
- Do they bring up more at night or in the day?
- What kind of weather suits them best?
- What effect does this work have upon the soil?
- What effect will their work have upon objects lying upon the surface of the ground?
- Follow out a burrow and find how deep it is. Draw.
- Do worms live singly or in numbers in one hole?
- What do earthworms eat? Try cabbage, onion and other leaves.
- Where do they feed?
- What enemies do they have?
- How does it protect itself from these?
- Does it fight or hide?
- Is it alike on both sides of the body?
- What differences and why?
- Draw body backward between the fingers and describe what you feel.
- How help in moving?
- How does the earthworm crawl?
- Can it move backwards?
- Is it easy to draw the worm from his burrow?
- If you cut a worm in two what happens?
- Account for the lighter pink band around the body of the worm.
- What do the eggs look like? Where are they found? How many worms come from the one capsule?
- Can a worm live in water? How long? In the sun on dry earth?
- How do you know when they are suffering? Put worm in wet earth and put in sun. Is it less uncomfortable?
- Do you see any blood?
- Can the worm distinguish between light and darkness? Test in dark room with candle. Can it hear? How do you know? How sensitive is it to the sense of touch? Can it smell? Try it with any strong odors like peppermint or wintergreen oil. Compare the snakes method of movement with the worm.

## THE MOON

### GRADES.

The moon is a subject especially suited to the Fifth, Sixth and Seventh grades. It is valuable in the Fifth Grade as a spur to the imagination. An exhaustive treatment of the subject is not to be attempted, the object being rather to incite the child to observation and to bring out some of the strong contrasts which the moon offers to our own planet. The motions of the moon are rather difficult for the average Fifth Grade, but if they gain a rough idea of the motions in this grade, after a year or two they will be able to grasp the ideas involved easily.

### METHOD OF OBSERVATION.

At the time of "new moon" by the almanac, tell the children to be on the lookout for the moon, assigning for special observation the first few points given below. When they have reported on these, assign other questions, a few at a time, until the moon has been watched through all its phases. As the children report the results of their own observations, have discussions on the motions, size, distance, etc., taking care not to let too many points come up in one recitation. Some topics might well be preceded by assigning thought questions bearing upon the subject overnight.

### QUESTIONS.

1. In what part of the sky do you see the new moon?
2. What shape is it?
3. Which way do the horns of the new moon point?
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24. On what side does the first break in the circle appear?
25. What is the appearance of the moon when seen in broad daylight?
26. What change takes place in the terminator during the week following full moon?
27. One week after full moon what is the shape of the terminator?
28. At this time, how much of the face of the moon is lighted?
29. Is this the same half that was lighted at the end of the first week?
30. Predict the changes that will take place between this half moon and the next new moon.
31. Notice the date for the next new moon by the almanac and look for the moon on that night.
32. Does the moon rise and set every day?
33. What is meant by the expression "the dark of the moon?" Where is the moon at that time?
34. Is the sun east or west from the moon when it is waxing? Waning?
35. Are the ends of the crescent turned toward or from the sun?
36. What part of the earth is always light?
37. What part of the moon is always light?
38. Does the moon rise and set every day?
39. Do the spots on the moon ever seem to change?
40. Are all sides of the moon alike? (How many sides have we ever seen?)
41. Describe the appearance of the moon at the end of the first quarter; second quarter; third quarter; fourth quarter.
42. What are the uses of the moon?

#### MOTIONS OF THE MOON.

The diurnal motion.—About two days after new moon by the almanac, the moon will appear shortly after sunset in the western sky not far from the sunset point. A few minutes later she, too, will have

set below the western horizon. This motion of the moon from east to west is an *apparent* motion, due, like that of the sun, to the diurnal rotation of the earth upon its axis.

The moon's *real* motion.—Looking the next night at the *same hour* as before, the observer will find the moon in the west as before, but she will be a little higher above the horizon, *i. e.*, a little farther east than before. If this motion is apparent, it must be caused by the motion of the observer and earth; and the earth must have moved west to cause it. But we know that the earth moves east. We conclude that this must be a *real* motion of the moon. If the observer continues to watch the moon's motion at dark, he will find her every evening farther east among the stars; and in fifteen days she will have crossed the evening sky, and will be found at sunset on or near the eastern horizon. She will have made a half revolution around the earth. After this she will continue to move east, and, of course, she will at dark be on the heavens below the eastern horizon. After full moon she can be seen only by sitting up until she rises, but as she rises about fifty minutes later each night, it will not be many days before it will be necessary to get out of bed before light in the morning in order to see her. For any given date after full moon prophesy how early it will be by moonlight. (For the hours of moonlight for any given night see Jayne's Almanac.)

Note.—To show the apparent motion of the moon, have one pupil carry a spherical object (to represent the moon) around some larger object (to represent the earth) in the direction in which the hands of a clock move (clockwise). Then call the attention of the class to the clock itself, which, being vertical, shows this apparent motion even better than the foregoing.

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To show how it is that we see but one face of the moon, have one pupil walk around a globe representing the earth, with his face turned always toward the globe. As he has in turn faced all four walls of the room, it will be seen that he has revolved (rotated) once upon his axis. Nevertheless, the same side of his body was always turned toward the globe. The same thing may be well shown by the following simple apparatus: Lay a clock face down horizontally, and by means of sealing wax attach a marble (or other spherical object) to the center pin. Attach another smaller one by the same means to the end of the long hand. Give the hand one contraclockwise revolution; you have then represented one revolution of the moon around the earth. It takes the real moon  $29\frac{1}{2}$  days to accomplish this.

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*Third Quarter.*—Full moon marks the close of the second quarter and the beginning of the third. The full moon is on the opposite side of the earth from the sun. She rises at sunset and sets about sunrise. In her waning, the first break of light is on her western side. After the beginning of her third quarter she can generally be seen in the day time, because she is so far from the sun on the sky that he does not entirely obscure her light.

*Fourth Quarter.*—About twenty-one days after new moon she begins her fourth quarter. She is then a half moon again, and when seen when it is still dark in the morning she is nearly overhead, with her convex side turned toward the sun. After this we should find the moon drawing nearer the sun at sunrise, and about the twenty-seventh day after the new moon we should again see the faintly illumined full circle with the bright, slender crescent on the side next the sun. The faint illumination will be turned toward the sunny side of the earth below the eastern horizon. Finally, the moon would pass nearly between earth and sun, and then we should have new moon again. If the moon passed directly between earth and sun, it is clear that the moon would cut off the sun's light for awhile, and we should have an eclipse of the sun by the moon. Usually the moon is not just in line, so there is no eclipse. The expression "dark of the moon" is applied to that period after the disappearance of the waning crescent and before

the appearance of the waning crescent, when the moon is so nearly in a line between us and the sun that the light of the latter blinds our eyes, and we do not see it, even when it is above the horizon. This is the state of affairs toward the end of the fourth quarter and at the beginning of the first quarter. The moon is "dark" for a period of from three to four days.

#### RESUME OF PHASES.

First quarter—new moon (almanac) to half moon.

Second quarter—half to full.

Third quarter—full to half.

Fourth quarter—half to new.

#### STATISTICS CONCERNING SUN AND MOON.

(The following are round numbers.)

Diameter—2,160 miles. (That of earth, 8,000 miles.)

Surface—1-14 that of earth.

Bulk—1-50 that of earth.

Diameter of moon—1-400 that of sun.

Distance of moon from earth—1-400 that of sun.

Distance of moon from earth—240,000 miles.

Distance of sun from earth—93,000 miles.

Length of moon's day—29½x24 hours—708 hours. (Daylight, 354.)

#### SIZE.

It would take fifty moons to equal the earth in size, and 1,500,000 moons to make one sun. One author tells us that if the whole sky were covered with full moons, it would scarcely make daylight. It is now known that the surface of the moon is about as great as that of North and South America; but Anaxagoras, a wise Greek, was laughed at in olden times because he was so bold as to suppose that the moon was as large as all of Greece. (See map.)

Note.—After a discussion with the class on the apparent magnitude of the moon, read them chapter 3 of "Sky," one of the Rollo Books by Abbott.

Suggestions.—How many earth's diameters is the moon away from the earth? Draw a 1-foot circle on the board to represent the earth. Now the drawing of the moon must be placed 30 feet away, and should be how many inches in diameter? Relative size of sun and moon: If sun has 400 times the diameter of the moon, and we represent the moon by a quarter-inch circle, how large a circle must we draw for the sun? As it is impracticable to draw an eight-foot circle, cut both dimensions in two, and, making a ½-inch dot for the moon, draw a four-foot circle for the sun.

#### DISTANCE.

It is, as given above, about 240,000 miles, or 30 earth's diameters, or ten times around the earth. On a bridge, at four miles an hour, a man could walk to the moon in about seven years. With a good horse, trotting 240 miles a day, it would take three years. On a train, at sixty miles an hour, it would take six months. Traveling as fast as a cannon ball (15 miles a minute) it would take eleven days. On the contrary, if the sun were the destination, and an express train had been started for there in the middle of the seventeenth century, it would not be due there till now; and if a small group of people had started on the train, the seventh generation only would reach its destination.

#### SHAPE.

We now know the moon to be almost spherical, although we have seen but one side of it; but the ancients could not all agree as to its shape. One man thought that it was the shape of a basin or platter; some thought it a great mirror. Another, who lived before the days of Greece and Rome, thought that the moon was a globe with one side luminous, the other sky blue. He accounted for the phases by saying that sometimes the blue side was turned partly toward us. Some Indians explain the phases by saying that the moon is full of nectar; that when the moon wanes the gods are drinking this up, and that when the moon waxes the nectar is collecting again.

#### SUBSTANCE.

The ancients had different ideas as to what the moon was made of. Some thought it pumice stone; others said it was full of fire; others that it was congealed mist hardened by fire; others, a thick, compact cloud; others, a mixture of fire and air. The Buddhists say that "within it is composed of crystal, and its surface is of silver; so that both its surface and inner material are extremely cold." Children have long been told, and many grown people have believed, that the moon was "made of green cheese." There is a nursery rhyme of three children who went hunting at night:

One said it was the moon,  
Another said Nay;  
A third said it was a cheese,  
And half o't cut away.

The Greeks believed that the heavenly bodies were the home of the gods, and were made of divine substance, so that when the wise Anaxagoras began to teach that the moon was made of material like the earth and that, for all we know, might be inhabited by beings like ourselves, he was accused of impiety and condemned to death. Says Morton, in "Heroes and Science," "Anaxagoras is interesting as being the first martyr to science."

#### SURFACE.

The surface of the moon is very much broken by chains and masses of mountains. Many of these are in the form of extinct volcanoes. Sir John Lubbock says: "The geography of the moon, so far as concerns the side turned toward us, has been carefully mapped and studied, and may almost be said to be as well known as that of our own earth. The scenery is in a high degree weird and rugged; it is a great wilderness of extinct volcanoes, and, seen with even a very moderate telescope, is a most beautiful object. The mountains are of great size. Our loftiest mountain, Mt. Everett, is generally stated as about 29,000 feet in height. The mountains of the moon reach an altitude of over 42,000. But this reckons to the lowest depression, and it must be remembered that we reckon the height of mountains to the sea level only. Several of the craters on the moon have a diameter of forty or fifty—one of them even as much as seventy-eight—miles. Many also have central cones, closely resembling those in our own volcanic regions. In some cases the craters are filled nearly to the brim with lava. The volcanoes seem, however, to be all extinct, and there is not a single case in which we have conclusive evidence of any change in a lunar mountain." Says Bayne, in "The Pith of Astronomy:" "In consequence of the small gravity on the moon, the absence of the small expansive power of ice, and the levelling influence of rain, precipices stand, mountains shoot up like needles, and cavities three miles deep remain unfilled. These conditions give the moon grand and savage scenery, such as can not be found on the earth. It has twenty-eight mountains higher than Mt. Blanc; ten of these are over 18,000 feet high, the two highest, Mts. Leibnitz and Dorfel, being almost 25,000 feet each.

"These mountains have been measured with greater accuracy than any of our own, and in a general way the maps made of the moon are more reliable than those made of the earth. The extinct volcanic craters on the moon are enormous. The crater of Clavius has a diameter of 130 miles. By the aid of powerful telescopes 33,000 craters have been counted on the side of the moon which we see." The area enclosed by the crater called Ptolemy is equal to that of the State of Massachusetts. "Tycho, a crater 17,000 high and fifty miles across, has diverging from it a number of rays, or streaks, which for hundreds, or in some cases, two or three thousand, miles, pass straight across plains, craters and mountains. The true nature of these streaks is not yet understood." "They radiate especially from the three great craters, Tycho, Copernicus and Kepler. They do not appear to be elevations or depressions on the moon's surface. . . . An effort has been made to account for these appearances by supposing that the moon, in cooling, suddenly cracked; that these cracks afterwards became filled with melted lava which, when cool, presented a smooth surface capable of reflecting light. This, of course, is not more than conjecture."

"Some ancients thought the moon a large, well polished mirror, reflecting our own oceans and mountains; the dark spots representing our seas, and the bright patches our continents."

"The first rude idea of the real nature of the lunar surface was gained by Galileo (16th century) with his telescope." He suggested that the brighter and rougher portions might be continents, and the dark, smooth portions oceans. Many shared his ideas, and accordingly many of these dark patches were named as seas. "As the moon is now seen and mapped, the difference between the light and dark portions is due merely to a difference in the color of the material, much of which seems to be darker than the average of terrestrial objects."

#### ATMOSPHERE.

"The moon is a dead cinder; if it ever had air and water, which it probably had, they are now absorbed in the porous lava which covers its surface."—(Bayne.) "A marble building erected upon the surface of the moon would remain century after century just as it was left." Why? Is there any place on the earth where buildings "weather" less rapidly than in others? Did you ever hear the story of Cleopatra's Needle?

Our atmosphere looks blue to us because of the fine particles of dust floating in the air, which reflect the blue rays of light to us. To a person on the moon, the sky would appear black always, the stars would always be visible, and they would not appear to twinkle. Why do stars seem to twinkle when seen from earth?

Suggestion:—How does an object appear looked at through the hot air rising from the stove? across a heated field? From the moon there would be no sunset clouds, no color at all in the sky except when the sun is eclipsed by the earth. Then the atmosphere of the earth would appear as a bright colored ring around the earth. Having no atmosphere, the moon is not protected from showers of meteors. Proctor estimates that at least thirty million bodies, large and small, must actually strike the moon's surface each year, and probably some ten or twenty thousand of these are of the kind we call fire-balls. Have you ever seen shooting stars flash in our sky and disappear? They are meteors which started to fall to the earth, but became so hot through friction with the air that they glow. Most of them melt and turn to vapor before reaching the surface of the earth.

#### GRAVITY.

The attraction of all heavenly bodies for each other is called gravitation. The attraction of any one of these bodies for objects on its own surface, though not different in nature, is called "gravity." Because of the smaller size of the moon, it has less attraction for things on its surface than the earth has—about one-sixth as much. If a man can jump six feet high on the earth, how high could he jump on the moon?

How much would a grocer's pound weight weigh on the moon? A man weighs 150 pounds here; what would he weigh on the moon? Which could be climbed with the least effort, Mt. Everest or Mt. Leibnitz? (See section on "Surface.")

#### THE MOON'S DAY.

To a person living on the moon, how long would it be from sunrise to sunset? From sunrise to sunrise?  $29\frac{1}{2}$  hours is — hours?

Owing to the absence of atmosphere on the moon, the variations of temperature are very great. At midday it is more than hot enough to boil water, some say hot enough to melt lead, while at night it is fearfully cold, something like 200 degrees below zero. The difference between day and night is about 600 degrees.

#### MOON AND TIDES.

"We are indebted to the moon for many things; but the greatest of these is that it is principally owing to its attraction that we have the purifying motion of the seas known as tides. Without these daily currents the oceans would become stagnant and unhealthy to such an extent that we could not live on their shores."—(Bayne.) How much later is high tide one day than another? How much later does the moon pass a certain place in the sky one day than another? Is this a mere coincidence? Recall what has been said about the attraction of one heavenly body for another (gravitation). If the moon attracts our earth it must attract the water as well as the land. Why does the water in the ocean not go over to the moon? When an ocean is facing the moon, how could the moon change the shape of the surface of the ocean? This bulging of the water toward the moon is the cause of the tides. The sun also helps make tides. Are the sun and moon ever on the same side of the earth? What effect would that have on the tides?

#### ECLIPSES.

When you are reading in the evening, do you like to have someone stand between you and the light? What would be the effect if the moon should get directly between us and our light, the sun? What the effect if the earth should get between the sun and the moon? Do people know ahead of time when an eclipse is going to occur? The following story is told of how Columbus made use of the lunar eclipse of March 1, 1504, to obtain much needed supplies for his men. The inhabitants of Jamaica refused to give them to him, and he threatened to take away the moon's light if they did not do so. When the eclipse came on, the savages were struck with terror and hastened to supply his wants.—(Howe.)

#### COUNTING TIME BY THE MOON.

Which would be the longer, a day measured by the sun or one

measured by the moon? By which do we measure our year, the sun or the moon? Is our "month" an exact lunar month? The Indians used to reckon time by the lunar month. The year of the Winnebagoes began in spring. Their months were: (1) drying the earth; (2) digging the ground; (3) hoeing corn; (4) corn tasseling; (5) corn popping or harvest; (6) elk whistling; (7) deer running; (8) deer's horns dripping; (9) little bear's time; (10) big bear's time; (11) coon running; (12) fish running.

The Greeks divide the year into two seasons, winter and summer. The year begins immediately after the celebration of the ripening of the new corn in August. This makes their months run:

Aug.—big ripening moon.	Feb.—windy moon.
Sept.—little chestnut moon.	Mar.—little spring moon.
Oct.—big chestnut moon.	Apr.—big spring moon.
Nov.—falling leaf moon.	May.—mulberry moon.
Dec.—big winter moon.	June—blackberry moon.
Jan.—little winter moon.	July—little ripening moon.

The Kenistenos begin the year with May. This is their year:

May—fog moon.	Nov.—hoar frost moon.
June—moon when birds lay eggs.	Dec.—whirlwind moon.
July—moon when birds moult.	Jan.—cold moon.
Aug.—moon when birds begin to fly.	Feb.—big moon.
Sept.—moon when moose casts horns.	Mar.—eagle moon.
Oct.—rattling moon.	Apr.—goose moon.

Suggestion:—If the interest warrants it, have class vote each month on a name for the current lunar month. Have the voting done formally, in true parliamentary style.

#### MYTHS AND SUPERSTITIONS.

The Piute Indians say that the sun is a "big chief," the moon his wife, and the stars his children. The sun sleeps at night in a hole in the ground like the "sweat house" which a big Indian chief would use. But this sun chief is so big that he can not turn around in his sweat house; therefore he must go through in the morning and come out on the eastern side, and so rise in the east. He is fond of eating his children, the stars, so they keep away from him as much as they can, staying with their mother, the moon. But he has eaten many, which is the reason of his brightness; for it is his stomach full of stars which we see. And when he eats them, his wife, the moon, paints her face black, as the bereaved Piute mothers do. (Gould. "Beginnings.")

Here are some ideas of old-fashioned people about the moon: The moon produces blindness by shining in a sleeper's eyes. (Compare the idea that the sun puts out any fire upon which he shines.) It fixes the hour of death, which occurs at the change of tide. Cucumbers,

## THE MOON

### GRADES.

The moon is a subject especially suited to the Fifth, Sixth and Seventh grades. It is valuable in the Fifth Grade as a spur to the imagination. An exhaustive treatment of the subject is not to be attempted, the object being rather to incite the child to observation and to bring out some of the strong contrasts which the moon offers to our own planet. The motions of the moon are rather difficult for the average Fifth Grade, but if they gain a rough idea of the motions in this grade, after a year or two they will be able to grasp the ideas involved easily.

### METHOD OF OBSERVATION.

At the time of "new moon" by the almanac, tell the children to be on the lookout for the moon, assigning for special observation the first few points given below. When they have reported on these, assign other questions, a few at a time, until the moon has been watched through all its phases. As the children report the results of their own observations, have discussions on the motions, size, distance, etc., taking care not to let too many points come up in one recitation. Some topics might well be preceded by assigning thought questions bearing upon the subject overnight.

### QUESTIONS.

1. In what part of the sky do you see the new moon ?
2. What shape is it ?
3. Which way do the horns of the new moon point ?
4. Does the moon set at the same time every night ?
5. Does it set in the same place ?
6. What is the real shape of the moon ?
7. If you had never seen the moon except when it was new, would you know what shape the moon really is ?
8. Does the complete outline of the new moon appear to be a perfect circle ?
9. The following expression is sometimes found in books; what do you suppose it means ?—"The old moon in the new moon's arms."
10. How long is it after new moon by the almanac before the terminator forms a straight line ?
11. Is the terminator a smooth or a broken line ?
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16. Does the full moon rise before or after sunset? (Assign question on the day before full moon.)

17. With watch in hand, see how long it takes the full moon to rise.

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19. What is the color of the moon? Does the color vary during one evening?

20. Is the color the same one night as another?

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29. Is this the same half that was lighted at the end of the first week?

30. Predict the changes that will take place between this half moon and the next new moon.

31. Notice the date for the next new moon by the almanac and look for the moon on that night.

32. Does the moon rise and set every day?

33. What is meant by the expression "the dark of the moon?" Where is the moon at that time?

34. Is the sun east or west from the moon when it is waxing? Waning?

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*Second Quarter.*—During the second quarter, when the moon is increasing from half moon to full, is the most interesting time for telescopic observation.

*Third Quarter.*—Full moon marks the close of the second quarter and the beginning of the third. The full moon is on the opposite side of the earth from the sun. She rises at sunset and sets about sunrise. In her waning, the first break of light is on her western side. After the beginning of her third quarter she can generally be seen in the day time, because she is so far from the sun on the sky that he does not entirely obscure her light.

*Fourth Quarter.*—About twenty-one days after new moon she begins her fourth quarter. She is then a half moon again, and when seen when it is still dark in the morning she is nearly overhead, with her convex side turned toward the sun. After this we should find the moon drawing nearer the sun at sunrise, and about the twenty-seventh day after the new moon we should again see the faintly illumined full circle with the bright, slender crescent on the side next the sun. The faint illumination will be turned toward the sunny side of the earth below the eastern horizon. Finally, the moon would pass nearly between earth and sun, and then we should have new moon again. If the moon passed directly between earth and sun, it is clear that the moon would cut off the sun's light for awhile, and we should have an eclipse of the sun by the moon. Usually the moon is not just in line, so there is no eclipse. The expression "dark of the moon" is applied to that period after the disappearance of the waning crescent and before

the appearance of the waning crescent, when the moon is so nearly in a line between us and the sun that the light of the latter blinds our eyes, and we do not see it, even when it is above the horizon. This is the state of affairs toward the end of the fourth quarter and at the beginning of the first quarter. The moon is "dark" for a period of from three to four days.

#### RESUME OF PHASES.

First quarter—new moon (almanac) to half moon.

Second quarter—half to full.

Third quarter—full to half.

Fourth quarter—half to new.

#### STATISTICS CONCERNING SUN AND MOON.

(The following are round numbers.)

Diameter—2,160 miles. (That of earth, 8,000 miles.)

Surface—1-14 that of earth.

Bulk—1-50 that of earth.

Diameter of moon—1-400 that of sun.

Distance of moon from earth—1-400 that of sun.

Distance of moon from earth—240,000 miles.

Distance of sun from earth—93,000 miles.

Length of moon's day— $29\frac{1}{2} \times 24$  hours—708 hours. (Daylight, 354.)

#### SIZE.

It would take fifty moons to equal the earth in size, and 1,500,000 moons to make one sun. One author tells us that if the whole sky were covered with full moons, it would scarcely make daylight. It is now known that the surface of the moon is about as great as that of North and South America; but Anaxagoras, a wise Greek, was laughed at in olden times because he was so bold as to suppose that the moon was as large as all of Greece. (See map.)

Note.—After a discussion with the class on the apparent magnitude of the moon, read them chapter 3 of "Sky," one of the Rollo Books by Abbott.

Suggestions.—How many earth's diameters is the moon away from the earth? Draw a 1-foot circle on the board to represent the earth. Now the drawing of the moon must be placed 30 feet away, and should be how many inches in diameter? Relative size of sun and moon: If sun has 400 times the diameter of the moon, and we represent the moon by a quarter-inch circle, how large a circle must we draw for the sun? As it is impracticable to draw an eight-foot circle, cut both dimensions in two, and, making a  $\frac{1}{8}$ -inch dot for the moon, draw a four-foot circle for the sun.

#### DISTANCE.

It is, as given above, about 240,000 miles, or 30 earth's diameters, or ten times around the earth. On a bridge, at four miles an hour, a man could walk to the moon in about seven years. With a good horse, trotting 240 miles a day, it would take three years. On a train, at sixty miles an hour, it would take six months. Traveling as fast as a cannon ball (15 miles a minute) it would take eleven days. On the contrary, if the sun were the destination, and an express train had been started for there in the middle of the seventeenth century, it would not be due there till now; and if a small group of people had started on the train, the seventh generation only would reach its destination.

#### SHAPE.

We now know the moon to be almost spherical, although we have seen but one side of it; but the ancients could not all agree as to its shape. One man thought that it was the shape of a basin or platter; some thought it a great mirror. Another, who lived before the days of Greece and Rome, thought that the moon was a globe with one side luminous, the other sky blue. He accounted for the phases by saying that sometimes the blue side was turned partly toward us. Some Indians explain the phases by saying that the moon is full of nectar; that when the moon wanes the gods are drinking this up, and that when the moon waxes the nectar is collecting again.

#### SUBSTANCE.

The ancients had different ideas as to what the moon was made of. Some thought it pumice stone; others said it was full of fire; others that it was congealed mist hardened by fire; others, a thick, compact cloud; others, a mixture of fire and air. The Buddhists say that "within it is composed of crystal, and its surface is of silver; so that both its surface and inner material are extremely cold." Children have long been told, and many grown people have believed, that the moon was "made of green cheese." There is a nursery rhyme of three children who went hunting at night:

One said it was the moon,  
Another said Nay;  
A third said it was a cheese,  
And half o't cut away.

The Greeks believed that the heavenly bodies were the home of the gods, and were made of divine substance, so that when the wise Anaxagoras began to teach that the moon was made of material like the earth and that, for all we know, might be inhabited by beings like ourselves, he was accused of impiety and condemned to death. Says Morton, in "Heroes and Science," "Anaxagoras is interesting as being the first martyr to science."

SURFACE.

The surface of the moon is very much broken by chains and masses of mountains. Many of these are in the form of extinct volcanoes. Sir John Lubbock says: "The geography of the moon, so far as concerns the side turned toward us, has been carefully mapped and studied, and may almost be said to be as well known as that of our own earth. The scenery is in a high degree weird and rugged; it is a great wilderness of extinct volcanoes, and, seen with even a very moderate telescope, is a most beautiful object. The mountains are of great size. Our loftiest mountain, Mt. Everett, is generally stated as about 29,000 feet in height. The mountains of the moon reach an altitude of over 42,000, but this reckons to the lowest depression, and it must be remembered that we reckon the height of mountains to the sea level only. Several of the craters on the moon have a diameter of forty or fifty—one of them even as much as seventy-eight—miles. Many also have central cones, closely resembling those in our own volcanic regions. In some cases the craters are filled nearly to the brim with lava. The volcanoes seem, however, to be all extinct, and there is not a single case in which we have conclusive evidence of any change in a lunar mountain." Says Bayne, in "The Pith of Astronomy:" "In consequence of the small gravity on the moon, the absence of the small expansive power of ice, and the levelling influence of rain, precipices stand, mountains shoot up like needles, and cavities three miles deep remain unfilled. These conditions give the moon grand and savage scenery, such as can not be found on the earth. It has twenty-eight mountains higher than Mt. Blanc; ten of these are over 18,000 feet high, the two highest, Mts. Leibnitz and Dorfel, being almost 25,000 feet each.

"These mountains have been measured with greater accuracy than any of our own, and in a general way the maps made of the moon are more reliable than those made of the earth. The extinct volcanic craters on the moon are enormous. The crater of Clavius has a diameter of 130 miles. By the aid of powerful telescopes 33,000 craters have been counted on the side of the moon which we see." The area enclosed by the crater called Ptolemy is equal to that of the State of Massachusetts. "Tycho, a crater 17,000 high and fifty miles across, has diverging from it a number of rays, or streaks, which for hundreds, or in some cases, two or three thousand, miles, pass straight across plains, craters and mountains. The true nature of these streaks is not yet understood." "They radiate especially from the three great craters, Tycho, Copernicus and Kepler. They do not appear to be elevations or depressions on the moon's surface. . . . An effort has been made to account for these appearances by supposing that the moon, in cooling, suddenly cracked; that these cracks afterwards became filled with melted lava which, when cool, presented a smooth surface capable of reflecting light. This, of course, is not more than conjecture."

"Some ancients thought the moon a large, well polished mirror, reflecting our own oceans and mountains; the dark spots representing our seas, and the bright patches our continents."

"The first rude idea of the real nature of the lunar surface was gained by Galileo (16th century) with his telescope." He suggested that the brighter and rougher portions might be continents, and the dark, smooth portions oceans. Many shared his ideas, and accordingly many of these dark patches were named as seas. "As the moon is now seen and mapped, the difference between the light and dark portions is due merely to a difference in the color of the material, much of which seems to be darker than the average of terrestrial objects."

#### ATMOSPHERE.

"The moon is a dead cinder; if it ever had air and water, which it probably had, they are now absorbed in the porous lava which covers its surface."—(Bayne.) "A marble building erected upon the surface of the moon would remain century after century just as it was left." Why? Is there any place on the earth where buildings "weather" less rapidly than in others? Did you ever hear the story of Cleopatra's Needle?

Our atmosphere looks blue to us because of the fine particles of dust floating in the air, which reflect the blue rays of light to us. To a person on the moon, the sky would appear black always, the stars would always be visible, and they would not appear to twinkle. Why do stars seem to twinkle when seen from earth?

Suggestion:—How does an object appear looked at through the hot air rising from the stove? across a heated field? From the moon there would be no sunset clouds, no color at all in the sky except when the sun is eclipsed by the earth. Then the atmosphere of the earth would appear as a bright colored ring around the earth. Having no atmosphere, the moon is not protected from showers of meteors. Proctor estimates that at least thirty million bodies, large and small, must actually strike the moon's surface each year, and probably some ten or twenty thousand of these are of the kind we call fire-balls. Have you ever seen shooting stars flash in our sky and disappear? They are meteors which started to fall to the earth, but became so hot through friction with the air that they glow. Most of them melt and turn to vapor before reaching the surface of the earth.

#### GRAVITY.

The attraction of all heavenly bodies for each other is called gravitation. The attraction of any one of these bodies for objects on its own surface, though not different in nature, is called "gravity." Because of the smaller size of the moon, it has less attraction for things on its surface than the earth has—about one-sixth as much. If a man can jump six feet high on the earth, how high could he jump on the moon?

How much would a grocer's pound weight weigh on the moon? A man weighs 156 pounds here; what would he weigh on the moon? Which could be climbed with the least effort, Mt. Everest or Mt. Leibnitz? (See section on "Surface.")

#### THE MOON'S DAY.

To a person living on the moon, how long would it be from sunrise to sunset? From sunrise to sunrise? ( $29\frac{1}{2} \times 24$  hours is — hours?)

Owing to the absence of atmosphere on the moon, the variations of temperature are very great. At midday it is more than hot enough to boil water, some say hot enough to melt lead, while at night it is fearfully cold, something like 200 degrees below zero. The difference between day and night is about 600 degrees.

#### MOON AND TIDES.

"We are indebted to the moon for many things; but the greatest of these is that it is principally owing to its attraction that we have the purifying motion of the seas known as tides. Without these daily currents the oceans would become stagnant and unhealthy to such an extent that we could not live on their shores."—(Bayne.) How much later is high tide one day than another? How much later does the moon pass a certain place in the sky one day than another? Is this a mere coincidence? Recall what has been said about the attraction of one heavenly body for another (gravitation). If the moon attracts our earth it must attract the water as well as the land. Why does the water in the ocean not go over to the moon? When an ocean is facing the moon, how could the moon change the shape of the surface of the ocean? This bulging of the water toward the moon is the cause of the tides. The sun also helps make tides. Are the sun and moon ever on the same side of the earth? What effect would that have on the tides?

#### ECLIPSES.

When you are reading in the evening, do you like to have someone stand between you and the light? What would be the effect if the moon should get directly between us and our light, the sun? What the effect if the earth should get between the sun and the moon? Do people know ahead of time when an eclipse is going to occur? The following story is told of how Columbus made use of the lunar eclipse of March 1, 1504, to obtain much needed supplies for his men. The inhabitants of Jamaica refused to give them to him, and he threatened to take away the moon's light if they did not do so. When the eclipse came on, the savages were struck with terror and hastened to supply his wants.—(Howe.)

#### COUNTING TIME BY THE MOON.

Which would be the longer, a day measured by the sun or one

measured by the moon? By which do we measure our year, the sun or the moon? Is our "month" an exact lunar month? The Indians used to reckon time by the lunar month. The year of the Winnebagoes began in spring. Their months were: (1) drying the earth; (2) digging the ground; (3) hoeing corn; (4) corn tasseling; (5) corn popping or harvest; (6) elk whistling; (7) deer running; (8) deer's horns dripping; (9) little bear's time; (10) big bear's time; (11) coon running; (12) fish running.

The Greeks divide the year into two seasons, winter and summer. The year begins immediately after the celebration of the ripening of the new corn in August. This makes their months run:

Aug.—big ripening moon.	Feb.—windy moon.
Sept.—little chestnut moon.	Mar.—little spring moon.
Oct.—big chestnut moon.	Apr.—big spring moon.
Nov.—falling leaf moon.	May.—mulberry moon.
Dec.—big winter moon.	June—blackberry moon.
Jan.—little winter moon.	July—little ripening moon.

The Kenistenos begin the year with May. This is their year:

May—fog moon.	Nov.—hoar frost moon.
June—moon when birds lay eggs.	Dec.—whirlwind moon.
July—moon when birds moult.	Jan.—cold moon.
Aug.—moon when birds begin to fly.	Feb.—big moon.
Sept.—moon when moose casts horns.	Mar.—eagle moon.
Oct.—rattling moon.	Apr.—goose moon.

Suggestion:—If the interest warrants it, have class vote each month on a name for the current lunar month. Have the voting done formally, in true parliamentary style.

#### MYTHS AND SUPERSTITIONS.

The Piute Indians say that the sun is a "big chief," the moon his wife, and the stars his children. The sun sleeps at night in a hole in the ground like the "sweat house" which a big Indian chief would use. But this sun chief is so big that he can not turn around in his sweat house; therefore he must go through in the morning and come out on the eastern side, and so rise in the east. He is fond of eating his children, the stars, so they keep away from him as much as they can, staying with their mother, the moon. But he has eaten many, which is the reason of his brightness; for it is his stomach full of stars which we see. And when he eats them, his wife, the moon, paints her face black, as the bereaved Piute mothers do. (Gould. "Beginnings.")

Here are some ideas of old-fashioned people about the moon: The moon produces blindness by shining in a sleeper's eyes. (Compare the idea that the sun puts out any fire upon which he shines.) It fixes the hour of death, which occurs at the change of tide. Cucumbers,

radishes and turnips increase at full moon. Onions thrive best after the moon has passed its full. Herbs gathered before full moon make the best medicine. Shingles will curl up if not laid at the right phase of the moon. (Howe. A study of the sky.)

When the crescent moon hangs low in the west soon after sunset, if a line joining the horns is nearly horizontal so that the moon can apparently hold water, it is a "dry moon." If the line be tipped up at a very marked angle, the moon is called "wet." The absurd part of this is that, while the position of the horns can be predicted for thousands of years to come, no one can foretell the weather a week ahead. It is just as absurd to say that a change of phase means a change of weather. As there is a new phase every seven days, every change of the weather must take place within four days of a change of phase ! (Howe.)

#### THE MAN IN THE MOON.

Some people, looking at the full moon, see a likeness there to a human face. They call this appearance the "man in the moon." Others see the features of a beautiful lady, a small, very beautiful face, profile view. Others make out the body of a bent old man with a bundle on his back. To account for this latter appearance the following story is told to German children by their nurses : "Ages ago there went one Sunday an old man into the woods to hew sticks. He cut a faggot and slung it on a stout staff, cast it over his shoulder, and began to trudge home with his burden. On his way he met a handsome man in a Sunday suit walking toward the church. The man stopped and asked the faggot-bearer: "Do you know that this is Sunday on earth when all must rest from their labors?" "Sunday on earth or Monday in heaven, it's all one to me," laughed the wood-cutter. "Then bear your bundle forever!" answered the stranger. "And as you value not Sunday on earth, yours shall be a perpetual Moon-day in heaven; you shall stand for eternity in the moon, a warning to all Sabbath-breakers." Thereupon the stranger vanished; and the man was caught up with his staff and faggot into the moon, where he stands yet. Some say the stranger was Moses, some that it was Christ himself. (Proctor. Myths and marvels of astronomy.)

#### THE LUNAR HOAX.

In 1835 a phamplet, supposed to have been translated from the French by a man named Locke, was published in America. Within a month 60,000 were sold. The pamphlet contained a circumstantial account of the work of a prominent astronomer, Sir John Herschel, and some of his friends who, it was stated, had succeeded in rigging up a telescope of much higher power than any yet known, so that they were able to make out every detail of the moon's surface. On the night of

their first observation they saw on the moon a rocky cliff covered thickly with dark flowers much like our poppies. Next they saw a lunar forest whose "trees were of one unvaried kind;" next a lunar ocean, "the water nearly as blue as that of the deep sea, and breaking in large white billows upon the strand, while the action of very high tides was quite manifest upon the face of the cliffs for more than a hundred miles." After a description of several valleys, mountains and forests, the story introduces us to the discovery of animal life. In an oval valley "small collections of trees of every imaginable kind were scattered about, and in the shade of the woods we beheld brown quadrupeds like bison, only much smaller." The narrator goes on to describe reindeer, elk, moose and horned bears, and finally mentions a creature which is described as a biped beaver. It is found only along shores. "It carries its young in its arms like a human being, and moves with an easy, gliding motion. Its huts are constructed better and higher than those of many human savages, and, from the appearance of smoke in nearly all of them, there is no doubt of its being acquainted with the use of fire." When the observers discovered domestic animals they began to hope that they would soon see creatures more like human beings. The story continues: "On the eastern side of a narrow valley there was one soaring crag crested with trees. While gazing on these we were thrilled with astonishment to perceive four successive flocks of large winged creatures, wholly unlike any kind of birds, descend with a slow, even motion from the cliffs and alight on the plain. . . . Certainly they *were* like human beings, for as they walked along their wings disappeared and their attitude was both erect and dignified. They averaged four feet in height, were covered, except on the face, with short and glossy copper colored hair. The face, which was of a yellowish flesh color, was a slight improvement upon that of the large orang outang, being more open and intelligent in its expression. . . . These creatures were evidently engaged in conversation; their gesticulation, more particularly the varied action of their hands and arms, appeared impassioned and emphatic." Their wings are described as being very much like those of bats, hence the astronomers named these people *Vespertilio-homo*, or Bat-men. "So far as we could judge, they spent their happy hours in collecting various fruits in the woods, in eating, flying, bathing and loitering about the summits of the precipices." In the book called "*Myths and Marvels of Astronomy*," Proctor says of this moon story: "In its day it attracted a good deal of notice, and even when every one had learned the trick many were still interested in a story which was so cleverly conceived and had deceived so many. To this day the lunar hoax is talked of in America, where originally it had its chief, or rather, its only real success as a hoax." Editors all over the country fell into the trap prepared for them. The *Albany Advertiser* had read the article "with unspeakable

pleasure and astonishment." The *New Yorker* considered the discoveries "of astounding interest, creating a new era in astronomy and science generally."

Suggestion:—Give the class the gist of the foregoing, putting it into simpler language if necessary. Then tell them that men who knew even a little about the way in which telescopes were made saw at once that the telescope described in the above story was an impossibility, and so were not deceived. What is one use, then, of nature study or elementary science? What are some other ways in which people are likely to be deceived by other people? (Inventors of impossible machines trying to raise money; "salted" mines; cure-all medicines, etc.)

#### BIOGRAPHICAL BITS.

(From "The Pith of Astronomy," by S. G. Bayne.)

*Copernicus*.—Born in Prussia, A. D., 1473. To Copernicus must be given the first place in astronomy, for it was he who, in the face of all traditions, founded the Copernican system: placing the sun in the center, with the planets revolving round it. Previous to 1543 all astronomers placed the earth in the center of the universe, and believed that the stars and planets revolved around it.

*Galileo*.—Born in Pisa, Italy, 1564. He discovered the properties of the pendulum in 1583, constructed a thermometer in 1597, and invented and constructed the first telescope in 1609. With these appliances he made many important astronomical discoveries. His was the greatest opportunity given to man in the field of exploration, as the new glass placed him where no one had stood before; but the invention was his, and he used it to the fullest extent. He was imprisoned in Rome for accepting the Copernican system.

*Sir Isaac Newton*.—Born in England in 1642. Newton was the greatest mathematical astronomer and was a veritable wizard with figures, distancing all men who had lived before him, or who have appeared since. The story of the fall of the apple was first told by Voltaire, who obtained it from Newton's niece. Laying down the laws of universal gravitation was his principal work.

*Sir William Herschel*.—Born in 1738. He discovered the planet Uranus and many other celestial bodies. With his own hands he constructed the first great telescope. He was the founder of modern astronomy. As an explorer of the heavens he had but one rival—his son.

*Tycho Brahe*, the celebrated Danish astronomer, was born in 1546. In an observatory built for him by the king, without the aid of a telescope and with the crudest instruments, he made observations that afterwards in the hands of Newton and Kepler were destined to settle the great problems of astronomy.

THE POET'S TRIBUTE.

"Daughter of heaven, fair art thou! The silence of thy face is pleasant! Thou comest forth in loveliness. The stars attend thy blue course in the east. The clods rejoice in their presence, O moon! They brighten their dark brown sides. Who is like thee in heaven, light of the silent night? The stars are ashamed in thy presence. They turn away their sparkling eyes. Whither dost thou retire from thy course when the darkness of thy countenance grows? Hast thou thy hall, like Ossian? Dweldest thou in the shadow of grief? Have thy sisters fallen from heaven? Are they who rejoice with thee at night no more? Yes! they have fallen, fair light! and thou dost often retire to mourn. But thou thyself shall fail one night and leave thy blue path in heaven. The stars will then lift their heads: they, who were ashamed in thy presence, will rejoice. Thou art now clothed with thy brightness. Look from thy gates in the sky. Burst the cloud, O wind! that the daughter of night may look forth, that the shaggy mountains may brighten, and the ocean roll its white waves in light." —From the poems of Ossian. Translated by James Macpherson, London, 1807. Quoted by Harley.

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REFERENCE TO ABOVE, BY SUBJECTS.

Atmosphere of moon, (9) p. 314.  
Calendar, (14) p. 34.  
Day, Lunar, (9) p. 311.  
Degrees, (1) p. 49-63.

- Distance, (any astronomy).  
Earth, (2) p. 22-28; (10) p. 711-14; (14) p. 19.  
Eclipses (any general astronomy.)  
General description of moon, (7); (15); (4) p. 113-132; (8) p. 326.  
Gravity at surface of moon, (4) p. 110.  
History of moon, (7); (12) "Is the moon dead?" p. 144; "The moon's a myriad small craters" p. 182; (13) 81-97.  
Hoax, Lunar, full account of, (11) 241-66.  
Light and heat of moon, (9) p. 317.  
Map of moon, (5), frontispiece.  
Motions of moon, (4); (8) 152-4.  
Mountains of moon, (12) p. 132; (13) p. 105.  
Myths and superstitions, (4) 174-179.  
Phases, (4) p. 96; (8) p. 154-6.  
Size, apparent, (1) p. 38-47; (4) p. 81.  
Sun, (1) p. 18; (6) p. 382-87; (10) p. 707-11; (14) p. 48.  
Surface, (any astronomy) (13) p. 101.  
Tides, (8) p. 166-67; (9) p. 319.  
Trip to the moon, (3) p. 265.

#### ILLUSTRATIONS.

(Will teachers kindly add references as they come across them?)  
(2); (5) (map); (7); (14); (15); (16).

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The following list of books arranged with reference to subject it is hoped will help teachers in looking up any subject they are to teach. Reference is made to the few books in our libraries. The reference list is but a beginning and consequently incomplete. Each teacher in the department is requested to send in at once any good reference she may discover in her reading and this list will be added to from time to time.

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" ..... Outings at Odd Times  
" ..... Travels in a Tree Top  
" ..... Recent Rambles or in Touch With Nature  
" ..... Wasteland Wanderings  
Allen, Grant ..... Flash Lights on Nature  
" ..... Common Sense Science  
Ballantyne ..... Essays in Mosaic  
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" ..... Birds and Poets  
" ..... Fresh Fields  
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Doe ..... An Elk Hunt in the Rockies  
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Gaye, Selina ..... Great World's Farm  
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"	.....	Autumn
"	.....	Summer
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"	.....	The Foot Path Way
"	.....	A Rambler Lease
Van Dyke	.....	Little Rivers
"	.....	Fisherman's Luck
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"	.....	In the Wilderness
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Winthrop, Theodore	.....	Life in the Open Air
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"	.....	Geographical Distribution of Animals, p. 272
"	.....	Instinct and Reason, p. 240, Adaptation, p. 123
Keep, Josiah	.....	Shells and Sealife
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I desire to present to you, and through you, to the patrons of our schools, a detailed report of the High Schools of our city.

From articles printed, from time to time, in our newspapers, and from consultation with many capable and honest patrons of our schools, I am convinced that there is an entire misunderstanding of the conditions in our Department in relation to our High Schools. It may be of interest to know why the Ninth Grade pupils were centralized in the Central School.

During the year 1891-1893, from money obtained from a bond issue, largely increased school facilities were constructed. The new High School building made it possible to vacate the building at the corner of Twelfth and Market Streets. In this bond issue, no additional school facilities were provided for that section of the city west of Lake Merritt, north of Seventh Street and south of Thirty-sixth Street, except the five-room building on Prospect Avenue and Broadway, known as the Grant School. It is true that the Lafayette School building was constructed from money obtained from this bond issue, but this was to replace almost, if not entirely as large a building, which was formerly situated on the site now occupied by the High School building.

The Board of Education recognized that by the construction of the High School building, and by its occupancy for High School purposes, the building at Twelfth and Market Streets would be available for the accommodation of other pupils. Manual Training had been and was then, carried on in the Oakland School Department in an unsatisfactory way. The Board of Education, therefore, for three reasons desired to centralize all of the Ninth Grade pupils in the building at Twelfth and Market Streets.

First, it was absolutely necessary to secure room in other sections of the city for the accommodation of the younger pupils.

Second, that better facilities might be furnished for Manual Training work.

Third, for educational reasons, other than those referred to under the heading of Manual Training.

The problem of room could be solved in no other way than by transferring to this school the upper grade pupils of all the schools. Had we opened in this school a regular Grammar and Primary school, the schools in the immediate vicinity would have been relieved of overcrowded classes. But it would not have been possible to centralize the younger pupils so as to relieve the crowded condition of the outlying districts. By the centralizing of the upper grade Grammar pupils, the overcrowded condition of the following schools was immediately relieved: Lincoln, Cole, Prescott and Durant. That is, instead of having our vacant rooms all in one section of the city, by transferring the upper grade pupils to the central section of the city, the vacant rooms were distributed to all parts of the city.

In most of the buildings named above, we had at the time referred to, half-day classes in the First Grade. This was made imperative on account of lack of room. It will certainly be apparent to anyone who will give this matter attention, that the centralization of the pupils was an absolute necessity for the distribution of needed school facilities in other parts of the city.

The Manual Training of our Department had been carried on for years in two or three central points in the city. This proved unsatisfactory, as many of the pupils who were in the classes were not willing to take Manual Training in addition to the regular academic work. It was deemed expedient by the Board of Education to centralize the pupils and permit them to have the option of Manual Training in place of certain academic training. The results attained in our Central School in Manual Training have demonstrated beyond a doubt the wisdom of the Board of Education in this particular.

Our Department had been offering prior to the year 1892-1893 opportunities for a three years' course in all High School subjects. The demands for preparation for the University were so increased at this time that it was impossible to prepare the children for admission to the University with less than four years' Latin and four years' English. Two options were presented to the Board of Education:

First, to increase the course in the High School to four years, leaving nine years' in the Grammar and Primary school, thus making a thirteen years' course in our school, or,

Second, to so arrange the course of study in the Grammar and Primary schools as to make eight years the maximum work of these schools, making the additional year available for High School work, thus leaving our Department with eight years of Grammar and Primary school work and four years of High School work.

The latter, that is, eight years of Grammar and Primary school work and four years of High School work, is the universally accepted distribution of school time throughout the United States. Indeed, I do not recall any city schools organized in any other way.

The Board of Education determined to place the Oakland schools upon the same footing as schools of other cities. Having determined to introduce as soon as practicable Latin, High School English, High School Mathematics and High School Science into the Ninth Grade, it became necessary that these pupils should be centralized, to the end that Departmental work might be introduced into this grade.

It will be readily seen that it was impossible to leave the Ninth Grade pupils in the Grammar school buildings and at the same time provide the pupils with the best teachers, without at the same time very materially increasing the cost of tuition.

For these three reasons, or in fact for any one of the reasons, the Board of Education is justified.

WHY THE NINTH GRADE WAS BY ACTION OF THE LAST  
BOARD OF EDUCATION DECLARED A HIGH SCHOOL  
GRADE.

SECTION 6, Article IX of the Constution of the State of California, reads as follows:

"The public school system shall include primary and grammar schools, and such high schools, evening schools, normal schools and technical schools as may be established by the Legislature, or by municipal or district authority; but the entire revenue derived from the

State School Fund and the State School Tax, shall be applied exclusively to the support of primary and grammar schools."

The County School Fund, by legislative enactment, is placed in the same category as the State School Fund. It is, therefore, apparent that our High School cannot be maintained from funds derived either from the State or County.

From the year 1892-1893 to the year 1899-1900 inclusive, the expense of the Ninth Grade was paid out of the State and County funds, but during all these years (except the year 1899-1900) the city contributed to the Common School Fund more money than the expense of the Ninth Grade. Technically, if this was a High School grade during these years, the Board of Education and the County Superintendent of Schools erred in paying the expenses of this grade from the Grammar and Primary school fund; but it was a mere technical wrong, for the city during these years more than supported the Ninth Grade classes. The question of dispute therefore is, and ought to be, whether or not the Ninth Grade is a High School grade.

Unfortunately, the law does not define specifically what shall constitute a High School, nor where the Grammar and Primary school shall stop and the High School begin. Where the law is silent, we must appeal to general custom. We are now teaching in the Ninth year precisely the same studies that were, prior to 1893-1894, taught in the first year of our High School course, to wit: Latin, High School English, High School Mathematics.

The subject taught does not, however, make the grade of pupils. If a pupil has completed the Grammar school course, he is no longer a Grammar Grade pupil, and the city cannot impose upon the State and County the expense of additional education that it may deem wise to give such pupils.

The remark is often made that Manual Training and Commercial subjects are not High School subjects. It is not the subject that determines the grade of the school, but the grade of the pupil. There is not a pupil in the Central school building who has not completed the eight years of our Grammar and Primary school work. It therefore follows that these

are all High School pupils, and it matters not what line of work is pursued by these pupils, the expense should not be thrown upon the State and County.

As I said before, there is no definition in law of a High School pupil. The only safeguard against a community shirking its responsibility in the matter of High School education is the County Superintendent of Schools. It is made his duty to determine the grade of the schools in his county at least once a year. It is also made his duty to apportion the State and County school funds to the Grammar and Primary schools of the County. Any school that he has declared a High School cannot be maintained out of the State and County Fund.

Last May the Board of Education endeavored to so arrange matters that part of the expense of the maintenance of the Ninth Grades might be paid from the State and County Fund. The County Superintendent, however, exercising his authority under the law, declared the Ninth Grade no longer a grade to be classed as a Grammar school grade, and refused absolutely to permit any part of the expense whatever of this grade to be paid out of the State and County Funds. I herewith quote Superintendent Crawford's letter in full:

July 25, 1900.

"Mr. McClymonds,  
Secretary Board of Education,  
City of Oakland, Cal.

DEAR SIR:

"I acknowledge the receipt of the report of the Classification Committee, and of the report of the Finance Committee of your Board, under date of June 7-8, 1900. Since these reports directly question the grade of the school located at Twelfth and Market streets, and since the grade of the school will answer the question 'From what Fund shall salaries and other expenses be drawn?' it is my duty to suggest to the Board of Education of the Oakland School District and to the High School Board of the City of Oakland, the reasons which compel me to class the aforesaid school as I do.

"The fifth resolution of your Classification Committee reads as follows: 'That the Ninth year's work shall include both Grammar School and High School subjects.' This virtually makes a *mixed* grade school. The Political Code of California nowhere recognizes schools of this class. The difficulties attending such a classification are serious.

Judging from an opinion given by one of our State Superintendents, a similar question has arisen and has been answered.

"On page 379 of Anderson's Manual No. 636, the following is found: 'High School cannot embrace Primary nor *Grammar grades*; nor can Primary or *Grammar schools* embrace *High School grades*.'

"You propose to do just what this opinion declares cannot be done, and to intensify the act, not only by mixing High School grades and Grammar School grades in the same school, but you propose to mix in *one grade* Grammar and High School studies.

"Certainly the prohibition in the opinion given above would apply with greater force to your proposed grade mixing. I know of no law which will prohibit your having grammar or even primary studies taught in your High School; but High School studies cannot be taught in the grammar or in the primary grades. May I suggest a difficulty that would certainly arise? Suppose a pupil in this school were to take a part of the subjects mentioned in Section 6 as Grammar Grade subjects, and a part of those named in Section 7 as 'Sub-junior, High School Grade' subjects. In making out the report to the Superintendent, how shall these pupils be classified?

"Again, what educational body would have authority over these pupils? The Board of Education of the Oakland School District has no authority to legislate in matters affecting the High School, and the High School Board of the City of Oakland has no authority to legislate in matters touching the common schools. Shall there be a mixed Board to legislate for this mixed grade? That I may not seem discourteous in using the word 'mixed,' I quote from the report of your Finance Committee: 'By the adoption of the recommendation of the Classification Committee, the *Central School* becomes a mixed school as it were—part being *Grammar* and part *High School*.'

"In another part of the report the Committee speaks of 'High School salaries' and of 'Grammar School salaries,' and further along provision is made to pay a part of the mixed principal's and a part of the mixed janitor's salary from the High School Fund and a part from the Grammar School Fund. (See sub-division 3rd of recommendation of Finance Committee.) The assumption is of a mixed school. Such a school finds no place in the classes of public schools of California. I think you will agree with me that such proposed classification cannot be made. I see no way by which the salaries of teachers, teaching in a grade which embraces the studies proposed by your Classification Committee for your grade, and which requires the words 'Ninth Grammar Grade' and 'Sub-Junior High School Grade' to name it, can be paid out of any public school funds under my control. As soon as I have received from your Classification Committee the course of study for the pupils attending the Central School, I shall definitely name the grade of said school, unless your Board shall, in the meantime, have fixed it.

This is one of the duties of the County Superintendent. Statutes of Cal. Chap. LXV. Sec. 1543, sub-division 15th, Pol. Code of Cal. Sec. 1543, sub-division 15th.

"In view of the foregoing, would it not be well for the High School Board of the City of Oakland to treat the Central School as a High School? thus making it a municipal school, which the Constitution of the State of California authorizes according to Art. IX, Sec. 6. By doing so, the High School Board can exercise the right of fixing a course of study which may embrace such technical studies as the High School Board in its wisdom may adopt. This seems to me the sensible, sufficient, legal way to proceed.

Respectfully,

T. O. CRAWFORD,

County Supt. Schools,  
Alameda County, Cal."

It seems to me that this letter is conclusive. Personally, I consider the reasoning of the County Superintendent of Schools correct. The County Superintendent is the one authorized by law to determine the grading of the schools. He has acted. His conclusions are final. Therefore there should be no further controversy about whether or not the expense of maintaining the Ninth Grade is to be paid out of Grammar, Primary or High School funds.

These are grounds, however, that are debatable.

First, should the Oakland School Department maintain two High Schools? It seems to me that this is the question that should be discussed before the public. All over the East, in the most progressive communities, there are being maintained Polytechnic High Schools. These schools are popular, practical, and are serving an absolute need in the educational field. I take it that Oakland wants all that is good in education.

We have in our city schools a larger percentage of High School pupils than most other cities. Oakland boasts of her educational advantages. From a material standpoint, it is to our interests to continue to give special and careful attention to the maintenance of educational facilities.

Much has been said in reference to vacant rooms in the High School building. There are, in this building, twenty-

two school rooms, exclusive of laboratories, gymnasium, and the evening school rooms in the basement. The evening school rooms are not available for day purposes on account of imperfect lighting. Fourteen of the twenty-two rooms are now occupied. Upon investigation, I am convinced that forty additional pupils of the same grade as those now occupying the rooms, might be accommodated without using any additional room.

There are, in the Central School and Ninth Grade classes of the Franklin School, 485 pupils. Deducting from this number the 40 pupils referred to above, we have 445 pupils. To accommodate these pupils properly, ten rooms are necessary. That is, if all of the pupils outside of the brick High School building were transferred to this building, and all required to follow the curriculum as laid down for the pupils who are now in the building, two more rooms would be necessary to furnish accommodation.

No one, for a moment, would advocate the abolishment of the Commercial Department. Such subjects as Book-keeping and Stenography require especially fitted up rooms or laboratories. At least two additional rooms would be needed to accommodate these pupils. So it is apparent that if Manual Training were entirely abolished from the Ninth year, and all High School pupils transferred to the brick building, we would, on the opening of schools, be compelled to provide at least four additional school rooms. These are the present conditions. Our schools are growing rapidly, and it is therefore impossible to attempt to accommodate all the High School pupils under one roof.

If Manual Training is to be maintained in the Ninth Grades and moved to the main High School building, at least six additional school rooms fitted up as special laboratories for Mechanical Drawing, Cooking, Sewing and Woodwork, are needed. So to maintain the schools on the present footing, ten more school rooms are needed than are to be found in the brick building. The matter, therefore, of transferring all of the High School pupils to one building ought not to be seriously considered.

It may be of interest to you to know how much the city has contributed for schools during each of the past ten years. The following table is self-explanatory:

Year	Assessed Value of Property	Tax Rate	Amount of Rate Apportioned to School	Average No. of Pupils Belonging	Money Raised by City for Schools
1891-92	\$42,739,380	\$1 10	0 26	7,327	\$ 111,122 38
1892-93	44,481,343	1 24	0 24	7,416	106,755 22
1893-94	44,821,230	1 12	0 10 *0 09	7,521	95,160 33
1894-95	45,382,330	1 12	0 09 0 10	7,807	86,226 42
1895-96	46,597,343	1 00	0 08 0 09	8,831	79,215 48
1896-97	45,259,249	1 10	0 02 0 09	8,041	49,785 16
1897-98†	46,913,410	1 12	0 07 0 10	9,067	79,752 79
1898-99	42,391,955	1 21	0 03 1/2 0 09	8,865	52,989 94
1899-00	43,275,381	1 17	0 01 1/2 0 09 1/2	8,992	47,602 91
1900-01	43,390,168	1 17	0 00 0 10	9,210	43,390 00

\* Since 93-94 apportionments have been made for School Fund and High School Fund, the lower figures being the High School rate.

† This includes annexed territory.

It will be seen at a glance that the rate of taxes for schools has gradually diminished from 26 cents in 1891-1892 to 10 cents in 1900-1901.

I present these figures to show that the schools are receiving less and less from the city yearly. You will note that the assessed valuation of property has decreased from \$46,597,343 in 1895-1896 to \$43,390,168 in 1900-1901. The average number of pupils belonging has increased from 7327 in 1891-1892 to 9210 in 1900-1901.

The rate of taxation for school purposes levied by the County Supervisors in the years indicated in the above table is as follows:

In 1891-1892	.11.4 cents
1892-1893	.10
1893-1894	.15

1894-1895	.15
1895-1896	.18
1896-1897	.17
1897-1898	.24
1898-1899	.23
1899-1900	.25
1900-1901	.25

You will note that in general, up to the year 1897-1898, there was a gradual increase in the County rate for school purposes. That during the past four years, taking into consideration the decrease in the assessed valuation, the income from the county for school purposes has remained the same from year to year.

Prior to the year 1897-1898, we were receiving from the county a marked increase from year to year, owing to an increase in the county rate for school purposes. For this reason, it was possible to conduct the schools on a lower rate from the city.

Unfortunately for this Department, while the increase from the county ceased in 1897-1898, the decrease in the city rate for school purposes has continued until it has reached the low rate of 10 cents for 1900-1901.

In the above table you will note the low rate that was allowed for the High School in 1895-1896. This rate did not yield sufficient revenue to maintain the High School for the entire year. The school was closed two weeks earlier than the usual time, the teachers losing 1-21 of their annual salary, or 4 5-7 per cent; in the aggregate about \$1800. In 96-97 all the schools were closed one week earlier than the usual time, the teachers and janitors of the entire department losing 1-42 of their annual salary, or about 2 5-7 per cent; in the aggregate about \$4500. In 1900-1901 the schools were kept open until the close of the year, but the High School teachers received for their last month's pay only  $\frac{2}{3}$  of the regular amount. From present indications, it is not likely that they will receive any more salary for services rendered during 1900-1901. So I place this as a loss of 1-36 of the

year's salary, or 24-5 per cent; approximately \$1800. The teachers of the High School have lost during the last few years the equivalent of 10-15 per cent of one year's salary.

During the year 1899-1900 the school fund was unexpectedly increased by money received from the inheritance tax. Oakland's share of this tax was approximately \$16,000. This accounts for a larger surplus at the close of the year than usual.

The balance carried over in all funds during the past few years are as follows :

1895-1896	\$ 7,320
1896-1897	5,710
1897-1898	12,088
1898-1899	6,517
1899-1900	10,195

The somewhat excessive balance of 1897-1898 is explained by the fact that the County rate for school purposes is fixed after the City rate has been determined. The County rate for 1897-1898 was made 7 cents more than for the year 1896-1897. The excessive balance of 1899-1900 is explained, as I said before, by the unexpected increase in the State fund from the inheritance tax. You will note that in the year 1896-1897 the schools were closed, and still a balance of \$5,710 carried over. This money was obtained from the school districts annexed. This annexation occurred in the month of May, but was not definitely settled until some time afterwards.

The management of our High Schools in the present condition is not satisfactory educationally, nor is it understood by the public. I would therefore recommend that the course of study in the High School be so changed as to provide a four years' course in each of the courses offered in that school.

Second, that the course of study in the Central High School be so changed as to provide two courses of two years each; one a Commercial Course, the other a Manual Training Course.

Further, that a one year's Commercial Course be provided in the Central High School. That the pupils who are graduates of the Grammar schools be permitted to enter either High Schools.

That the name "Central High School" be changed to "Commercial and Polytechnic High School."

I make this recommendation because I am convinced that the people of this city will willingly support a Commercial and Polytechnic High School.

Furthermore, the plan upon which we have been conducting our Central High School has not given the time nor the room needed to make the Polytechnic School what it should be.

By the change recommended above, we will have in the Polytechnic High School only those pupils who are anxious to take this line of work. The building has been so crowded in the past that there was insufficient room to give the space needed for laboratory work in technical lines of education. This change will undoubtedly decrease the number of pupils in the Central School, but it will in no way decrease the number of pupils taking up Polytechnic work. Many pupils may at first enter the High School who might be better trained in the Polytechnic School, but this will only be temporary, and pupils will soon select, by the aid and advice of parents and teachers, the school best suited to furnish them the needed assistance in preparation for their life work.

The Manual Training Course recommended above is temporary only. I trust the Board of Education during this coming year may be able to find sufficient funds to furnish the necessary apparatus to provide a three years' course in Manual Training work.

This city is able to, and of a right ought to maintain as good a Polytechnic School as is to be found anywhere. The records of the San Francisco Polytechnic schools show that many pupils from Oakland and adjoining country cross the bay daily to avail themselves of the Manual Training facilities offered in the schools of this class located in San Francisco.

### Physical Culture in the High School

For the last six years a specialist has been employed by your Honorable body to devote her time to the physical condition of the pupils of the High School. The overcrowded condition of the school has made it impossible to offer the needed physical training to boys and girls alike. The specialist has devoted her entire time to the girls of the school. I am certain that Miss Palmer's report of the work that she is doing in the High School will prove interesting and satisfactory to you. I hereby quote her report in full:

#### DEPARTMENT PHYSICAL CULTURE, HIGH SCHOOL.

MR. J. W. MCCLYMONDS,

City Superintendent of School, Oakland, Cal.

The system of Physical Culture in the High School is based upon a careful physical examination of each pupil and a special assignment of exercises designed to meet, as far as possible, the individual physical requirements.

The examination is most thorough, consisting of the usual measurements, test of lung capacity, etc., and a careful examination of heart and lungs, of neck, shoulders, chest, hips, spine, skin, muscular condition, vision and hearing, and the physical history, including diseases and injuries. In all, over sixty items are taken into account and a careful record kept of the findings of the examination, of the exercises and instruction given, and the result.

Practical instruction is given in personal hygiene, including diet, sleep, exercise, bathing, clothing, habits of posture, etc.

In addition to the regular exercises in the gymnasium, all of which are individualized according to the needs of the pupil, a large amount of individual *corrective* work is given, especially in cases of spinal curvature, drooped neck, contracted chest, round shoulders, defects resulting from disease or injury, and one sided or unequal development from any cause. This special *corrective work* has generally been considered impossible to any extent in the public schools, and even in many of the colleges, but we have demonstrated that it is both possible and practicable, and we are doing an increasing amount of it every term with most gratifying results.

By means of this individual attention, we have been able to cure many slight and moderate cases of spinal curvature and other defects, and to greatly benefit the severe cases which had become incurable before reaching us. The improvement has been so great in many cases as to far surpass our expectations, and in a few instances it has surpassed what had been considered possible. We have had especially

gratifying results in cases of narrow, hollow or flat chest, and abnormally low lung capacity; in some instances increasing the lung capacity twenty cubic inches in one term.

The record of a few cases selected from among a great many may be of interest.

CASE I. A girl with lateral curvature of spine, back very weak, poorly developed chest, round shoulders, and general strength extremely poor. For a time little or no progress was made, as she so frequently came with requests to be excused from gymnasium because of backache. Finally I sent for her mother, showed her the record of her daughter's physical examination, and explained that what she needed was *more*, instead of less exercise, and suggested that the daughter come to the gymnasium *every day* and take special work. It was so arranged, and the girl has taken her work faithfully every day with excellent results. Her back has increased in strength so much that she now takes exercises with the utmost ease which were at first very difficult. The curvature and other defects are markedly improved, and her gain in general strength has been very great. She voluntarily told me that she practically never has a headache now, that the exercises no longer tire her, and that she feels much better in every way.

CASE II. (A graduate). Was excused from the gymnasium on physician's certificate while in school, but after graduation she came back *because of her physician's advice* and, after obtaining permission of the Board of Education, has been coming to the gymnasium daily to take the exercise which she should have taken when a member of the school. Her gain has been most remarkable in view of her general physical condition.

CASE III. Physically below par in every way. She brought an excuse from physician, but after she had been out of the gymnasium for a time, came back voluntarily and requested to be allowed to take special work, and is now taking such work daily with the approval of her physician, and with satisfactory results in increased strength and improvement in chest development.

CASE IV. General strength so poor that when she entered the gymnasium she could take but a few minutes' exercise at a time, and could use only the very lightest weights. She now goes through the entire lesson, using average weights. She is not yet a *strong* girl, but her gain is remarkable. She affords an example of improvement *in spite of herself*, as she dislikes exercise and simply takes what she must.

CASE V. Flat footed, marked curvature of spine, poorly developed chest, and general strength *very poor*. Her mother came to request an excuse from gymnasium, but when I showed her the record of her daughter's physical examination, and suggested giving her special work, she was very anxious to have her take it, and expressed great appreciation of the opportunity offered. The girl is now taking gymna-

sium regularly, and while not a promising case, because of poor constitution, is still undoubtedly improving.

CASE IV. Ankylosis of elbow joint resulting from tuberculous inflammation several years ago; arm small and weak. With her physician's consent we tried the effect of daily special exercises, with the surprising and most gratifying result that there is actually increased movement. In addition to this, the arm is much larger and stronger.

And so I might continue, but these cases will suffice for illustration.

It is not very easy to arrange for all of this special work, in fact, it is most difficult, but it can be done, and it *must* be done if physical training in our schools is to accomplish all that it should. The appreciation of our work as shown by remarks of parents and notes from them has been steadily increasing.

Many pupils come at the close of the term to express their appreciation of the benefits desired, especially from the corrective exercises, and many parents send messages and notes expressing the same thought.

The pupils who go to the gymnasium *daily* do so voluntarily, as the school requires them to take but two lessons a week, and the fact that the number of those who attend every day is constantly increasing is significant.

Respectfully,

CAROLINE B. PALMER,

Physical Director.

*Adm. Secy*

## MANUAL TRAINING

### Sewing

OAKLAND, May 31, 1901.

To J. W. McCLYMONDS,  
City Superintendent Schools,  
Oakland, Cal.

DEAR SIR:—

The number of pupils who received lessons in Sewing during  
the first term of the year 1900-1901 is ..... 132  
Number of lessons per week ..... 4  
Number of weeks in the term. .... 20  
Length of lessons. .... 1 hour

These pupils are divided into grades as follows:

From the 11th grade, Central School. .... 0  
From the 10th grade, Central School. .... 11  
From the 9th grade, Central School. .... 121

Number of pupils who received lessons in Sewing during the  
second term of the year 1900-1901 is. .... 118  
Number of lessons per week ..... 4  
Number of weeks in the term ..... 21  
Length of lessons. .... 1 hour

These pupils are divided into grades as follows:

From the 11th grade, Central School. .... 0  
From the 10th grade, Central School. .... 9  
From the 9th grade, Central School. .... 109

Respectfully,

MARY L. FEEL,

Teacher of Sewing.

### Cooking

OAKLAND, May 31, 1901.

To J. W. McCLYMONDS,  
City Superintendent Schools,  
Oakland, Cal.

DEAR SIR:—

The number of pupils who received instruction in Cooking during  
the first term of the school year 1900-1901 is. .... 108  
Number of lessons per week ..... 1  
Number of weeks in the term. .... 20  
Length of lessons. .... 1 hour

These pupils are divided into grades as follows:

From the 11th grade, Central School. .... 0  
From the 10th grade, Central School. .... 1

From the 9th grade, Central School.....	107
The number of pupils who received instruction in Cooking during the second term of the year 1900-1901 is.....	106
Number of lessons per week.....	1
Number of weeks in the term.....	21
Length of lessons.....	1 hour
These pupils are divided into grades as follows:	
From the 11th grade, Central School.....	0
From the 10th grade, Central School.....	3
From the 9th grade, Central School.....	103

Respectfully,

MARY L. FEEL,

Teacher of Cooking.

In the B Ninth classes the lessons are two hours in length, and are given every other week.

### Drawing

OAKLAND, May 31, 1901.

To J. W. McCLYMONDS,  
City Superintendent Schools,  
Oakland, Cal.

DEAR SIR:—

The number of pupils who received lessons in Drawing during the first term of the year 1900-1901 is.....	112
Number of lessons per week.....	30
Number of weeks in the term.....	20
Length of lessons.....	1 hour

These pupils are divided into grades as follows:

From the 11th grade, Central School.....	
From the 10th grade, Central School.....	14
From the 9th grade, Central School.....	98

Number of pupils who received lessons in Drawing during the second term of the year 1900-1901 is.....	120
Number of lessons per week.....	28
Number of weeks in the term.....	21
Length of lessons.....	1 hour

These pupils are divided into grades as follows:

From the 11th grade, Central School.....	
From the 10th grade, Central School.....	18
From the 9th grade, Central School.....	102

Respectfully,

G. GALE,

Teacher of Drawing.

### Wood Work

OAKLAND, May 31, 1902.

To J. W. McCLYMONDS,  
City Superintendent Schools,  
Oakland, Cal.

DEAR SIR:—

The number of pupils who received instruction in Wood Work during the first term of the year 1900-1901 is .....	137
The number of lessons per week .....	30
The number of weeks in the term.....	20
Length of lesson .....	1 hour

These pupils were divided into grades as follows:

From the brick High School building.....	10
From the 11th grade, Central School.....	
From the 10th grade, Central School.....	11
From the 9th grade, Central School.....	116

Number of pupils who received instruction in Wood Work during the second term of the school year 1900-1901 is.....	145
Number of lessons per week .....	30
Length of lessons.....	1 hour
Weeks of instruction.....	21

These pupils are divided into grades as follows:

From the brick High School .....	11
From the 11th grade, Central School.....	
From the 10th grade, Central School.....	20
From the 9th grade, Central School.....	114

Respectfully,

R. P. GLEASON,

Teacher of Wood Work.

The cost of tuition in the High School has been decreased during the year from \$70.60 per pupil to \$64.68 per pupil.

It will be of interest to know what it is costing per pupil in each of the laboratories of the High School and Central High School.

There were in the Physical Laboratory of the High School an average of 125 pupils. The cost for supplies was \$68.85. The cost of instruction and supervision, exclusive of the principal, was \$1600.

Cost per pupil for supplies.....	\$ .56
Cost per pupil for instruction.....	12.84
	<hr/>
Total per pupil.....	\$13.40

There were in the Chemical Laboratory an average of 59 pupils.

The cost for supplies was.....	\$ 112.05
The cost of instruction and supervision, exclusive of principal, was.....	\$1590.00
Cost per pupil for supplies.....	\$ 1.90
Cost per pupil for instruction.....	26.96
	<hr/>
Total per pupil.....	\$28.26

The total number of pupils in the Biological Laboratory per term was 109.

The cost of supplies was.....	\$ 30.70
The cost of instruction and supervision was	\$1590.00
The cost per pupil for supplies was	\$ .28
The cost per pupil for instruction and supervision was .....	14.80
	<hr/>
Total cost per pupil.....	\$15.08

The average number of pupils in the Manual Training Department for the year was 141.

The cost for power was .....	\$187.94
The cost for tools.....	49.40
The cost for supplies.....	340.00

Total cost for shop....	\$577.34
Cost for instruction.....	\$1,800.00
Cost per pupil.....	\$ 4.09
Cost per pupil for instruction .....	13.47

Total cost per pupil.....	\$17.56
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The average number of pupils per term who received lessons in cooking was 107.

The cost for supplies and gas was .....	\$ 65.25
The cost for instruction was .....	\$500.00
The cost per pupil for supplies and gas	\$ .60
The cost per pupil for instruction...	4.67

Total cost per pupil.....	\$5.27
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The average number of pupils receiving instruction in sewing was 125.

The cost for supplies was.....	\$ 94.14
The cost for instruction was .....	500.00

Total.....	\$594.14
The cost per pupil for supplies was..	\$ .75
The cost per pupil for instruction...	5.00

Total cost per pupil.....	\$5.75
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#### TABULATION OF COST PER PUPIL.

Physical Laboratory.....	\$13.40
Chemical .....	28.86
Biological.....	15.08
Wood work .....	18.56
Cooking.....	5.27
Sewing.....	5.75

## **SCHEDULE OF SALARIES FOR FISCAL YEAR 1901-1902**

I herewith submit a copy of the schedule of salaries of the year for 1901-1902.

1. The maximum salary for any given position shall be fixed at a certain sum per annum.

2. For the convenience of the Board of Education these salaries shall be divided into twelve equal payments, to be paid only so long as there are funds available, and at such times as the Board of Education may hereafter direct.

3. Any teacher who shall be absent, or who shall resign from the school department during the school year, shall receive in the aggregate such a part of the salary for the year as the number of weeks of service rendered is of the total number of weeks of service required.

4. For the maximum salary teachers shall render forty-two weeks of service.

5. Should there not be sufficient funds to maintain the schools during the entire forty-two weeks, the Board of Education reserves the right to order closed either the Grammar and Primary schools, or the High schools, or both Grammar and Primary and the High schools, and to pay the teachers and other employees of the schools ordered closed, in full of all demands, such a part of the maximum salary fixed for the position held, as the weeks of service rendered is of the forty-two weeks of service required.

6. All teachers and other employees of the School Department who shall be elected to the Department shall be subject to all the foregoing provisions.

The maximum salaries for the year ending June 30, 1902, shall be as follows:

Superintendent of Schools, per annum .....	\$3,000
Assistant Superintendent of Schools, per annum .....	1,800
Stenographer in office of Superintendent .....	600
Department Mechanic with horse and wagon .....	1,500

PRINCIPALS.

Principals of schools of more than ten classes, per annum .....	\$1,900
Principals of schools of eight, nine or ten classes, per annum .....	1,480
Principals of schools of five, six or seven classes, per annum .....	1,300
Principals of schools of four classes, per annum .....	1,080

The increase or decrease of number of classes shall not change rate of salary until the end of the currant fiscal year.

- (1) Teachers of Primary grades, except teachers of the First grade, who are graduates of neither a university nor a college, and who have a Grammar grade certificate or its equivalent, and have had less than two years' experience in teaching in the public schools, per annum .....\$600
- (2) Teachers of Grammar grades, and teachers of the First grade, who are graduates of neither a university nor a college, and who have a Grammar grade certificate, or the equivalent, and who have had less than two years' experience in teaching in the public schools, per annum.....\$660
- (3) Teachers of Primary grades, except teachers of the First grade, who are graduates of a university or a college, and who hold a Grammar grade certificate, or its equivalent, and who have had less than two years' experience in teaching in the public schools, per annum.....\$720
- (4) Teachers of Grammar grades, and teachers of the First grade, who hold a Grammar grade certificate or its equivalent, and who are graduates of a university or college, but who have had less than two years' experience in teaching in the public schools, per annum.....\$780

- (5) Teachers of Primary grades, except the teachers of the First grade, holding a Grammar grade certificate or its equivalent, who have had two or more years' experience in teaching in the public schools, per annum.....\$840
- (6) Teachers of the Grammar grades, and teachers of the First grade, who hold a Grammar grade certificate, or its equivalent, and who have had two or more years' experience in teaching in the public schools, per annum.....\$900

In all mixed classes the salary shall be that of the highest grade taught. Should a teacher of Second grade classes be required to teach a First grade class that was not able to complete the work of the First grade within the year, she shall not receive any additional salary for such work. Should a Grammar grade teacher be required to teach the highest Primary grade work to a class that was not able, within the year, to complete the Primary grade work, she shall not for this reason lose any salary.

The salary of teachers employed for only one-half of each day, dividing the school day at noon, shall be paid half the full salary for the position.

**SPECIAL TEACHERS IN GRAMMAR AND PRIMARY SCHOOLS.**

Supervisor of Drawing, per annum .....	\$1,500
Supervisor of Music.....	1,200
Supervisor of Physical Culture.....	1,200
Supervisor of Nature Study for full time in Grammar and Primary schools.....	1,000
Supervisor of Penmanship and Bookkeeping, day time.	1,400

**EVENING SCHOOL.**

Principal Central Evening School, per annum.....	\$900
Teacher of class for High School studies, per annum ....	600
Teacher of other classes in Evening School, per annum..	480

JANITORS OF GRAMMAR AND PRIMARY SCHOOLS.

Bay .....	per annum.....	\$ 700
Clawson .....	" " .....	750
Cole.....	" " .....	1,200
Durant .....	" " .....	1,200
Franklin.....	" " .....	1,020
Garfield.....	" " .....	1,080
Grant .....	" " .....	650
Grove Street .....	" " .....	480
Harrison.....	" " .....	650
Lafayette.....	" " .....	1,080
Lincoln.....	" " .....	1,170
Peralta .....	" " .....	360
Piedmont .....	" " .....	600
Prescott .....	" " .....	1,170
Swett.....	" " .....	750
Temescal.....	" " .....	600
Tompkins.....	" " .....	840
Common School Assembly Hall, per annum .....		60
Peralta (outside), per annum .....		60
Bay Annex, per annum .....		60

HIGH SCHOOL SALARIES.

Principal of Oakland High School, per annum.....	\$2,580
Principal Central High School, per annum.....	2,100
High School teacher (except as hereinafter provided) who have had less than two years' experience in teaching High School pupils in public High schools, per annum .....	1,080
High School teachers (except as hereinafter provided) who have had two, and less than three years' ex- perience in teaching High School pupils in public High schools, per annum.....	1,200
High School teachers (except as hereinafter provided) who have had three, and less than five years' ex- perience in teaching High School pupils in public High schools, per annum.....	1,260

High School teachers (except as hereinafter provided) who have had five or more years' experience in teaching High School pupils in public High schools, per annum.....	1,320
A teacher employed one-half of each day (except as hereinafter provided) shall receive per annum for forenoon work 60 per cent of the salary he would receive for full time; and for afternoon he shall receive 50 per cent of the salary he would receive for full time.	
Teacher of Cooking and Sewing .....	1,100
Teacher of Stenography and Typewriting.....	1,100
Services of pianist for gymnasium exercises, \$2 per day for each day's service.	
Principal's clerk, High School, per annum.....	600
Teacher of Manual Training in Wood Work, from 9 A. M. to 3:00 P. M., or 10 A. M. to 4 P. M.....	1,500
Teacher of Astronomy and Physical Geography (day time), fifteen hours per week.....	600
Teacher of Astronomy .....	1,200
Teacher of Industrial Drawing, from 9 A. M. to 4 P. M.	1,120
Head of Department of Science and Chemistry, in addi- tion to regular salary of teacher .....	460
Heads of other departments, in addition to regular salary .....	285

#### JANITORS.

Oakland High School.....	\$1,740
Central High School.....	1,200
Gardener for Oakland High School.....	240
Observatory.....	180

NOTE.—The above salaries represent, not what the teacher or employees receive in cash, but the amount of warrants issued. To realize cash, the holders of the warrants must pay discount during the year in the aggregate equal to about  $1\frac{1}{2}$  per cent of the annual salary.

By examining the foregoing it will be seen that the sala-

ries of the High School teachers have, in several instances, been reduced. This has been made necessary by the lack of money in the High School fund. The last meeting of the Legislature, however, passed a general law which it is generally believed will make it possible for the Council to levy a special tax for High School purposes, thus rendering it possible in the future to raise sufficient money to pay the salaries in full of our teachers.

## NEEDS OF THE OAKLAND SCHOOL DEPARTMENT

It will be absolutely necessary, if the efficiency of this Department be maintained, that additional rooms be provided for the accommodation of pupils. By examination of the enrollment in the different rooms, at the present writing, it is found that nearly one-half of the class rooms in the Department contain fifty-four pupils each. This is at least ten pupils more in each room than there should be.

By examining the report of the census marshal it will be seen that there are nearly five hundred more census pupils in Oakland this year than there were last year. The schools are growing so rapidly that it is not possible longer to accommodate all the pupils. Two additional temporary rooms have been constructed in the central part of the city, but the classes are still much overcrowded. It will therefore be necessary to provide by bond issue for additional school facilities.

In my last report, I submitted a detailed statement of the needs of the Department, and I can only repeat what I said then, and urge that the case is still more pressing than it was then. A bond issue of at least \$400,000 ought to be made to provide the needed school facilities for the next seven or eight years. By examining the statistics of cost as set forth in the following tables, it will be seen that the cost of High School tuition has been materially reduced, while the cost of Grammar and Primary tuition has remained virtually the same as it was.

The tables hereto attached and made a part of this Report will answer many interesting questions in reference to the statistics of the Department.

In closing this Report, I desire again to acknowledge the cordial support that I have received from the teachers, principals, and your Honorable Body in my efforts to make the schools of Oakland what they ought to be.

Very respectfully yours

J. W. McClymonds,  
City Superintendent Schools and ex-officio  
Secretary Board of Education.

**Table Showing Comparative Cost per Pupil in High School for Fiscal Years 1889 to 1901.**

HIGH SCHOOL.	Fiscal Years		Number of School Days.		Average Daily Attendance of Pupils.		Number of Teachers.		Average Number of Pupils per teacher		Salaries Paid for Teaching and Supervision.		Average cost per Pupil for Salaries for Teaching and Supervision.		Current Expenses Exclusive of Salaries.		Cost per Pupil, exclusive of Salaries.		Total Current Expenses, Including Salaries.		Average cost per pupil, based on total current Expenses.	
	Fiscal Years																					
	1889-1890	172	476	13	36.6	\$ 20,574	\$43.22	\$ .25	\$5,834	\$12.25	\$0.07	\$26,408	\$55.48	\$0.32								
	1890-1891	201	543	16	34.0	23,786	43.80	.21½	3,022	5.57	0.028	26,808	49.37	0.24½								
	1891-1892	199	589	18	32.7	27,500	46.69	.23½	3,075	5.22	0.027	30,575	51.91	0.26								
	1892-1893	197	622	19	32.7	29,560	47.55	.241	3,930	6.30	0.032	33,490	53.85	0.27½								
	1893-1894	207	634	20	31.7	33,186	52.35	.253	3,949	6.22	0.03	37,145	58.58	0.283								
	1894-1895	189	677	24	28.2	35,308	52.15	.27½	5,080	7.46	0.04	40,388	59.61	0.31½								
	1895-1896	196	767	23	33.3	35,548	46.34	.237	4,257	5.55	0.028	39,805	51.89	0.26¼								
	1896-1897	195	625	23	27.2	33,997	54.40	.278	5,033	8.05	0.042	39,030	62.45	0.32								
	1897-1898	198	544	22	24.7	33,001	60.83	.307	5,367	9.87	0.049	38,458	70.69	0.36								
	1898-1899	198	468	17	27.5	28,983	61.93	.312	4,102	8.76	0.044	33,085	70.70	0.356								
	1899-1900	198	485	18	26.9	30,856	63.62	.321	3,386	6.98	0.035	34,242	70.60	0.356								
	1900-1901	196	518	18	28.7	30,027	58.00	.295	3,479	6.71	0.034	33,506	64.68	0.33								

**Table Showing Average Number of Pupils Attending High School  
from December, 1881 to June, 1901**

	Boys	Girls	Total	Gradu
December, 1881.....	121	186	307	24
June, 1882.....	126	202	328	30
December, 1882.....	121	191	312	33
June, 1883.....	118	203	321	24
December, 1883.....	131	202	333	33
June, 1884.....	117	184	301	26
December, 1884.....	131	177	308	27
June, 1885.....	148	194	342	16
December, 1885.....	156	212	368	29
June, 1886.....	166	242	408	23
December, 1886.....	195	260	455	22
June, 1887.....	175	239	414	24
December, 1887.....	205	247	452	34
June, 1888.....	221	258	479	25
December, 1888.....	253	284	537	68
June, 1889.....	223	278	501	40
December, 1889.....	274	296	571	38
June, 1890.....	262	326	588	28
December, 1890.....	274	340	614	45
June, 1891.....	294	347	641	33
December, 1891.....	308	359	677	70
June, 1892.....	308	364	672	38
December, 1892.....	328	387	715	70
June, 1893.....	302	395	692	33
December, 1893.....	335	403	738	74
June, 1894.....	306	400	706	42
December, 1894.....	356	458	814	35
June, 1895.....	342	489	831	44
December, 1895.....	367	517	884	55
June, 1896.....	290	415	705	36
December, 1896.....	303	427	730	36
June, 1897.....	493	429	722	72
December, 1897.....	257	371	628	46
June, 1898.....	246	363	609	62
December, 1898.....	176	300	476	45
June, 1899.....	186	317	503	49
December, 1899.....	171	330	501	54
June, 1900.....	194	312	506	56
December, 1900.....	184	290	474	26
June, 1901.....	209	309	518	57

## INCOME

### COMMON SCHOOLS.

Balances from last year .....	\$ 19,336.04
From State Apportionment.....	152,104.52
From County Apportionment.....	105,682.03
Tuition and Breakage .....	67.60
<hr/>	
Total Income.....	\$277,190.19
Total Disbursements.....	253,004.48
<hr/>	
Balance on hand close of year.....	\$ 24,185.71

### HIGH SCHOOL.

Taxes .....	\$ 42,931.77
Tuition and other sources.....	1,512.65
<hr/>	
Total Income.....	\$ 44,444.42
Total expense paid from High School fund.....	\$ 63,339.63
<hr/>	
Deficit.....	\$ 18,895.21

### SPECIAL FUND—OBSERVATORY.

#### Deposited in Oakland Bank of Savings.

Balance on hand July 1, 1900.....	\$ 11,245.57
Interest to January 1, 1901.....	162.70
Interest to July 1, 1901 .....	160.50
<hr/>	
	\$ 11,568.77

### DISBURSED.

#### August 20th.

Paid for Alterations of Building .....	\$ 1,440 00
Paid for New Carpets .....	173.62
Balance on hand August 20, 1901.....	9,955.12
<hr/>	
	\$ 11,578.77

Table Showing Assessed Valuation of City Property, Growth of School Department  
and Other Facts of Interest.

		Census Children	
	Loss	Gain	
1911	1,766	161	
1912	1,912	197	
1913	1,967	205	
1914	1,380	50	
1915	1,747	667	
1916	1,108	36	
1917	1,744	40	
1918	1,273	446	
1919	192	7	
1920	1,089	674	1,135



# Report of School Census, 1901.

LOCATION	Number of Children between 5 and 17 years of age.						Number of Children under 5 y'rs. of age			Number of Children between 5 and 17 years of age.				NATIVITY OF CHILDREN			Census Children	
	Total by Wards						White	Negro	Chinese	Attended Public Schools during a part of school year	Attended P R I- V A T E but not during the school year.	Who attended neither Public or Private Schools at any time during the school year.	Native Born	Foreign Born	TOTAL	Loss		Gain
	WHITE	NEGRO		CHINESE														
Old Ward Bounded-ries	Boys	Girls	Boys	Girls	Boys	Girls												
1st Ward	1136	1106					524			1321	342	579	2766		2,766	161		
2nd "	1437	1449	26	19	1		967	13		1994	105	833	3895	17	3,912	197		
2nd "An's	1162	1150	11	12	1		629	2		1574	196	566	2937	30	2,967	205		
3rd Ward	910	961	3	6	2		496	2		1404	144	334	2319	61	2,380	50		
4th "	888	1008	13	15	2		807	14		1593	88	245	2732	15	2,747	667		
5th "	349	541	1	1	9		207		1	527	171	202	1084	24	1,108	36		
6th "	769	691	9	6	7		255	3	4	1296	123	63	1694	50	1,744	40		
7th Piedmont (Outside)	1655	1708	6	1	3	1	894	1	4	2578	197	599	4173	100	4,273	446		
Totals	8378	8705	68	60	25	1	4808	35	9	12,378	1377	3482	21792	297	22,089	674	1135	

## Consolidated Statistical Report of City Superintendent

NAME OF SCHOOL:	Number of school days.	Whole No. of days' attendance.	Whole No. of days' absence.		Average Number being longed.	Average daily attendance.	Per cent. of attendance on average number belonging.	Whole No. of tardiness.		Whole number of boys enrolled on Register.	Whole number of girls enrolled on Register.	Total number enrolled.
			With valid excuse.	Without valid excuse.				With valid excuse.	Without valid excuse.			
	1	2	3	3	4	5	6	7	7	8	9	10
Bay—Grammar.....	196	15,872.0	1287.0	87.5	80.9	92.6	57	1	28	59		
"    Primary.....	196	65,573.0	4570.0	16.0	357.8	93.4	294	23	242	215		4
Clawson—Grammar.....	196	7,355.0	266.0	39.0	38.0	96.5	6		18	30		
"    Primary.....	196	66,737.0	2290.0	352.0	340.0	97.0	80		218	205		4
Cole—Grammar.....	196	45,146.0	2756.0	2.0	244.4	94.0	81	4	131	141		
"    Primary.....	196	98,151.5	6475.5	9.0	534.4	93.7	214	27	345	398		7
Durant—Grammar.....	196	62,703.0	4175.0	341.0	320.0	94.0	127		181	224		4
"    Primary.....	196	99,197.0	5310.0	533.0	506.0	95.5	170		362	356		7
Franklin—Grammar.....	196	40,999.0	1969.0	219.0	209.0	95.0	105		114	122		2
"    Primary.....	196	62,307.0	2981.0	333.0	318.0	95.0	134		249	224		4
Garfield—Grammar.....	196	16,860.5	808.0	90.0	86.0	95.0	39	3	55	54		1
"    Primary.....	196	82,048.0	4,826.5	81.0	443.7	94.0	240	80	311	291		6
Grant—Grammar.....	196	9,185.0	643.3	2.0	50.0	93.0	8	3	27	38		
"    Primary.....	196	49,819.0	3,174.5	22.0	270.5	94.0	49	20	197	159		3
Grove Street—Primary.....	196	31,332.5	2,508.5	94.5	170.0	94.0	155	142	135	123		2
Harrison—Primary.....	196	55,369.5	3,604.0	6.0	301.0	94.0	74	38	218	200		4
Lafayette—Grammar.....	196	22,446.0	1,370.5	9.5	122.6	94.0	31	13	57	81		
"    Primary.....	196	112,258.0	6,331.5	27.5	605.0	95.0	211	80	403	446		8
Lincoln—Grammar.....	196	72,785.0	3,238.0	11.5	388.0	96.0	46	22	204	255		4
"    Primary.....	196	75,143.0	4,004.5	97.0	404.0	95.0	127	49	301	305		6
Peralta—Grammar.....	196	4,883.0	425.5	27.0	25.0	92.0	23		23	19		
"    Primary.....	196	21,882.0	1,531.5	21.5	119.6	93.0	80	27	85	84		1
Piedmont—Grammar.....	196	8,070.5	400.5	1.5	43.0	95.0	6	6	22	28		
"    Primary.....	196	26,779.0	1,400.0	9.0	143.7	95.0	8	51	82	91		1
Prescott—Grammar.....	196	23,010.5	1,278.5	7.0	124.0	95.0	55	18	68	83		1
"    Primary.....	196	110,596.0	5,948.0	29.0	589.7	95.0	323	116	408	308		7
Swett—Grammar.....	196	10,727.5	735.5	7.0	58.5	93.0	57	2	35	41		
"    Primary.....	196	47,016.0	2,669.5	6.5	253.5	94.6	270	11	179	107		3
Temescal—Grammar.....	196	6,968.5	298.0	6.0	36.0	96.0	6	3	15	21		
"    Primary.....	196	48,118.5	2,853.0	96.0	260.0	94.5	94	161	208	160		3
Tompkins—Grammar.....	196	11,119.5	581.0	3.0	59.6	95.0	68	11	37	57		
"    Primary.....	196	57,994.5	4,219.0	105.5	318.0	93.0	347	97	226	216		4
Total Grammar.....	196	348,331.0	20,232.0	49.5	1929.6	94.6	740	86	1015	1253		22
Total Primary.....	196	1,111,321.5	64,697.0	621.5	5988.9	94.4	2870	922	4169	4008		81
Grand Total Day School.....	196	1,469,652.5	84,929.0	670.0	7918.5	94.5	3610	1008	5184	5261		104
Evening Classes.....	196	25,166.0	5,821.0		158.0	81.0			520	75		5
Total Common Schools.....		1,494,818.5	90,750.0	670.0	8076.5	94.2	3610	1008	5704	5336		110
High School.....	196	101,475.0	5,341.0	15.0	538.0	96.0	581	302	255	360		6
Central High and Franklin High School Classes.....	196	94,727.0	3,506.0	1115.0	501.0	96.0	493	198	236	365		6
		196,202.0	8,847.0	1130.0	1049.0	96.0	1074	500	491	725		12

# **of Schools for the year ending June 7, 1901.**

Whole number on roll to-day.	Entered who have not attended any other City public school during the school year.		Number received by transfers from other schools.	Number re-entered	Received from lower grade	Received from higher grade	Number received from like division	Number sent to like division	Number transferred	Number left	No. of promotion	Number remained to a lower grade	Number suspended	Number of non-residents	Number instances of truancy	Number of Indigents	Number of Cases of Corporal punishment	Number expelled	RECORD OF VISITS					
	Boys	Girls																	No. of visits to parents made by teachers.	No. of visits made by School Directors.	No. of visits made by Superintendent.	No. of school visits made by other persons.		
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
28	59	2	121	12	9	65	1	17	113	15	2	11	1	1	8	2	7	15	40	1	1	1	1	1
242	215	23	37	320	57	87	14	91	418	48	44	9	2	27	15	14	40	1	1	1	1	1	1	1
18	30	2	18	54	6	97	112	11	233	37	1	1	1	1	11	28	31	69	1	1	1	1	1	1
218	205	24	129	455	6	97	112	11	233	404	12	1	1	1	13	49	7	28	31	69	1	1	1	1
131	141	59	84	324	28	41	58	21	157	330	2	1	1	1	1	2	9	11	17	3	3	3	3	3
345	398	83	222	540	80	125	131	56	437	672	22	2	2	2	8	6	1	40	31	39	2	2	2	2
181	224	24	63	396	2	88	74	13	182	395	1	1	1	1	5	4	66	30	40	2	2	2	2	2
362	356	40	142	382	28	153	124	41	310	491	19	1	1	1	2	3	71	26	56	2	2	2	2	2
114	122	28	59	223	1	27	35	9	107	252	1	1	1	1	1	6	7	46	11	19	2	2	2	2
249	224	29	80	443	2	10	7	17	194	513	1	1	1	1	2	5	3	13	6	20	2	2	2	2
55	54	10	18	153	3	34	35	7	49	154	1	1	1	1	1	9	12	12	3	3	3	3	3	3
311	291	16	172	470	2	101	123	23	319	476	2	2	2	2	1	19	78	15	29	4	4	4	4	4
27	38	7	16	53	1	18	39	18	39	42	1	1	1	1	2	6	30	4	12	2	2	2	2	2
197	159	43	82	356	8	28	28	24	175	379	7	1	1	1	2	1	16	9	21	7	7	7	7	7
135	123	12	75	59	3	43	43	14	153	78	3	3	3	3	5	17	34	41	4	11	1	1	1	1
210	200	35	86	323	1	60	58	36	201	333	1	1	2	12	27	43	66	38	32	49	3	3	3	3
57	81	16	16	110	1	61	61	26	55	83	3	3	3	3	2	10	1	7	6	13	2	2	2	2
403	446	86	171	551	26	290	258	96	409	637	23	2	2	2	33	8	43	100	32	49	8	8	8	8
204	255	79	89	538	17	126	125	49	208	566	18	1	1	1	4	1	1	38	43	57	4	4	4	4
301	395	72	121	597	37	109	109	51	300	676	34	4	4	4	4	1	1	10	21	26	3	3	3	3
23	19	1	8	72	6	12	97	24	46	9	9	2	2	2	2	2	2	1	4	9	1	1	1	1
85	84	9	57	238	65	12	97	264	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
22	28	4	11	110	15	1	9	9	115	16	1	1	1	1	2	7	17	7	16	6	6	6	6	6
82	91	21	53	267	60	67	7	73	261	1	1	1	1	1	20	7	7	7	16	6	6	6	6	6
68	83	6	28	648	7	375	321	46	428	734	9	9	9	9	74	6	24	23	32	5	5	5	5	5
408	368	34	203	92	12	56	57	29	188	373	14	14	14	14	6	1	64	13	16	3	3	3	3	3
35	41	4	8	61	12	96	96	3	22	42	1	1	1	1	1	1	8	7	1	1	1	1	1	1
179	167	23	122	333	12	56	57	29	188	373	14	14	14	14	6	1	64	13	16	3	3	3	3	3
15	21	6	6	61	12	96	96	3	22	42	1	1	1	1	1	1	8	7	1	1	1	1	1	1
208	160	30	101	338	12	96	96	3	22	42	1	1	1	1	1	1	8	7	1	1	1	1	1	1
37	57	5	20	85	9	58	57	22	50	78	1	1	1	1	3	7	35	5	16	10	1	1	1	1
33	57	5	20	85	9	58	57	22	50	78	1	1	1	1	3	7	35	5	16	10	1	1	1	1
226	216	49	156	395	9	58	57	22	50	78	1	1	1	1	14	26	1	36	39	18	1	1	1	1
15	1015	1253	245	446	2549	71	446	445	183	1079	2503	53	4	16	23	71	60	231	155	244	178	1	1	1
20	4169	4008	629	2009	6558	355	1709	1590	575	4012	7387	285	6	51	137	272	280	619	311	520	460	1	1	1
5	5184	5261	874	2455	9107	426	2155	2035	758	5091	9890	338	10	67	160	343	340	850	466	764	643	1	1	1
3	518	75	2	10	9107	426	2155	2035	758	5091	9890	338	10	67	160	343	340	850	466	764	643	1	1	1
8	5702	5336	876	2465	9107	427	2155	2035	759	5629	9890	338	10	67	160	343	340	850	486	767	643	1	1	1
10	255	360	271	45	38	14	227	220	5	26	5	26	5	26	5	26	5	4	14	9	3	1	1	1
6	236	365	7	31	464	3	57	72	5	184	737	6	6	26	6	26	6	19	44	19	3	1	1	1
6	491	725	278	76	502	3	71	72	232	404	737	6	5	26	6	26	6	23	58	28	7	1	1	1

Estimated Valuation of Property.						Amount of Insurance on			Time	Expires
School	Land	Building	Apparatus and Furniture	Library	Total	Buildings	Furniture and Apparatus			
Bay .....	\$ 2,000	\$14,000			\$ 16,000	\$ 9,000	\$ 500		3	1904
Polytechnic.	30,000	20,000	\$ 6,000	\$ 200	56,200	12,000	4,000		3	"
Clawson .....	8,000	18,000	1,000	150	27,150	11,000	1,000		3	"
Cole .....	27,000	25,000	1,500	300	53,800	17,000	1,500		3	"
Durant .....	15,000	18,000	1,500	300	34,800	17,100	1,500		3	"
Franklin .....	25,000	18,000	1,200	300	44,500	12,000	2,000		3	"
Garfield .....	17,500	25,000	1,500	250	44,250	14,000	1,000		3	"
Grant .....	10,000	25,000	450	100	35,550	10,000	500		3	"
Grove St. ....	8,000	2,000	200	50	10,250	1,000	500		3	"
Harrison .....	10,000	35,000	300	50	45,350	10,000	1,000		3	"
High .....	75,000	180,000	12,000	500	267,500	24,700	2,600		3	"
Lafayette .....	40,000	65,000	1,500	300	106,800	18,000	1,200		3	"
Lincoln .....	28,000	20,000	1,500	300	49,800	14,000	1,500		3	"
Peralta .....	1,000	5,000			6,000	4,000	400		3	"
Piedmont .....	3,000	10,000			13,000	8,000	500		3	"
Prescott .....	13,500	18,000	1,500	300	33,300	15,000	800		3	"
Swett .....	15,000	50,000	300	100	65,400	14,000	500		3	"
Temescal .....	2,000	12,000			14,000	7,000	750		3	"
Tompkins .....	5,000	15,000	1,000	250	21,250	10,100	500		3	"
Observatory		4,000	7,000	200	11,200	2,000	7,500		3	"
Vacant Lot	2,250				2,250				3	"
Assembly Hall		7,000	4,000		11,000	5,500	4,500		3	"
Totals .....	\$337,250	\$586,000	\$ 42,450	\$3, 650	\$920,350	\$235,400	\$ 34,250			

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Location and Size of Lot.

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N. E. cor. San Pablo av & Crawford st., 130 ft on S. P., 270 on Crawford  
271 ft on Market by 155 ft on 12th, 60 ft on Myrtle.....  
400 ft front on Magnolia by 133½ on 32d st.....  
230 ft on Tenth by 193¾ ft on Union.....  
250 ft on 28th by 280 feet deep.....  
Entire Blk 300 ft square bet 9th and 10th Aves and E 16th and E 15th sts  
353 ft on East 17th st, 240 on 23d Ave.....  
205 ft front on Broadway by 200 ft deep on Prospect Ave.....  
200 ft on Grove by 100 ft deep.....  
150 ft. on Fourth Street, and 150 on Harrison.....  
Entire Block, 200x300 ft, bounded by Grove, Jefferson, 11th & 12th sts.  
207.51 ft front on West by 240 ft on 17th and 18th.....  
200 ft on Alice, 200 ft on Eleventh and 150 feet on Tenth.....  
S. side Alcatraz av., 225 ft. E. of Telegraph, 125 on Alcatraz, 280 ft. deep  
N. E. cor Echo & Piedmont avs; lots 11-12 Glen Echo Tract; 2 17-100 acrs  
270 ft on Campbell by 140 ft on Seward.....  
Entire Blk 300 ft square bet E. 19th and 20th sts and 12th and 13th aves  
S. W. cor. Temescal & Cherry Sts; 170 ft on Temescal; 190 on Cherry....  
250 ft on Fifth by 120 ft deep.....  
Public Park.....  
E. 14th Street, bet. 10th and 11th Avenues, 50x140 ft.....  
Lafayette Square.....

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**Table Showing Cost of Tuition and Supplies per Scholar in the  
Different Schools for School Year Ending June 30, 1901.**

Name of School. Grammar and Primary.	Average No. pu- pils belonging.	Cost of Station- ery and Supplies.	Average cost per pupil per year for Stationery and Sup- plies.	Salaries paid Teachers not in- cluding Special Teachers.	Average cost per Pupil per year for Teachers' Salaries.	Total Current Expenses for var- ious Schools.	Average Cost per Pupil based on current Expenses and average number belonging.
Bay .....	445	\$ 310 00	\$0 67	\$ 8,917 40	\$20 04	\$11,172 18	\$25 10
Clawson .....	389	220 00	0 56	9,210 91	23 67	10,733 84	27 60
Cole .....	778	343 00	0 44	18,394 56	23 64	20,637 19	26 52
Durant .....	874	494 00	0 56	18,027 93	20 62	20,747 86	23 74
Franklin .....	552	383 00	0 69	13,552 29	24 55	15,725 20	28 48
Garfield .....	534	379 00	0 71	14,409 25	27 00	16,899 12	31 65
Grant .....	321	100 00	0 31	6,778 51	21 11	8,021 56	25 00
Grove St. ....	170	128 00	0 75	3,777 25	22 21	4,582 04	26 95
Harrison .....	301	96 00	0 32	6,079 35	20 20	7,198 60	23 91
Lafayette .....	728	289 00	0 40	15,614 01	21 44	17,887 62	24 57
Lincoln .....	792	313 00	0 40	16,716 41	21 11	19,419 73	24 52
Peralta .....	147	135 00	0 92	3,798 15	25 83	4,730 83	32 18
Piedmont .....	187	89 00	0 48	4,624 44	24 73	5,989 95	32 03
Prescott .....	719	343 00	0 48	17,060 40	23 72	19,476 56	27 09
Swett .....	313	263 00	0 84	7,694 11	24 58	9,382 14	30 00
Temescal .....	296	191 00	0 65	7,727 87	26 10	8,937 10	30 19
Tompkins .....	378	192 00	0 51	9,675 72	25 60	11,385 24	30 12
Totals & Av. Special Teachers	7924	\$4,268 00	\$0 54	\$182,058 56	\$22 98	\$212,962 76	\$26 87
General Ex- pense Dept.				5,537 52	00 70	5,537 52	70
						12,571 18	1 58
Grand Total	7924	\$4,268 00	\$0 54	\$187,596 08	\$23 67	\$231,071 46	\$29 16
Day Schools							
Eve. Schools	158	92 30	0 58	2,784 00	17 62	3,318 58	21 00
High School	540	*290 71	0 54	30,027 28	55 60	33,506 08	62 04
Central and Franklin H. S. Classes	01	\$*652 80	\$1 30	\$ 24,267 55	\$48 44	\$ 27,463 80	\$54 82

\*Includes laboratory supplies.

Table Showing Comparative Cost per Pupil for Fiscal Years 1892 to 1901 inclusive.

Based on average daily attendance.

Day and Evening Schools Exclusive of High School	Fiscal Year.	Number of School Days.	Average Daily Attend- ance of Pupils.	Salaries Paid for Teach- ing and Supervision.	Average Cost		Current Expenses, Ex- clusive of Teachers' Sal- aries.	Cost per Pupil		Total Current Expenses of Teachers.	Average Cost per Pupil Based on Total Current Expenses.				
					Per Year	Per Day		Per Year	Per Day						
Day and Evening	1892-93	197	6433	\$166,189	93	\$25 68	00 13	\$43,408.84	75	\$00 03 1/2	209,598	77	\$	32 58	00 16 1/2
Day and Evening	1893-94	207	6566	167,926	45	25 57	00 12 1/2	33,654.62	5 13	00 02 1/2	201,581	07	30 70	00 14 1/2	
Day and Evening	1894-95	203	6694	168,309	55	25 14	00 12 1/2	36,188.53	5 40	00 02 1/2	204,498	08	30 55	00 15	
Day and Evening	1895-96	206	6827	168,352	77	24 66	00 12	35,453.92	5 19	00 02 1/2	203,806	69	29 85	00 14 1/2	
Day and Evening	1896-97	195	7621	165,833	33	21 76	00 11 1/2	33,165.92	4 35	00 02 1/2	198,999	25	26 11	00 13 1/2	
Day and Evening	1897-98	198	7939	194,128	04	24 45	00 12 1/2	48,825.40	6 15	00 03 1/2	242,953	44	30 60	00 15 1/2	
Day and Evening	1898-99	198	7800	194,843	08	24 98	00 12 6	44,428.00	5 70	00 02 8	239,271	08	30 67	00 15 1/2	
Day and Evening	1899-00	198	7936	195,750	40	24 66	00 12 4	42,249.60	5 32	00 02 4	238,000	00	30 00	00 15 1	
Day and Evening	1900-01	196	7619	190,380	12	24 98	00 12 7	44,009.92	5 79	00 02 9	234,300	04	30 76	00 15 7	
Recapitulation for Fiscal Year 1900-1901															
Day School	1900-01	196	7489	187,596	12	25 05	00 12 8	43,475.34	5 80	00 02 9	231,071	46	30 85	00 15 7	
Evening	"	196	130	2,784	00	21 41	00 10 9	534.58	4 11	00 02 1	3,318	58	25 52	00 13	

**Table showing number of Class Rooms in Building, Average Number of Pupils belonging to each School,  
Average Number of Pupils to each teacher, etc.**

	Number of Class Rooms in building					Average number of Pupils belonging, and Grades to which they belong.				Number of Teachers who teach classes.				Total No. Teachers and Principals.				Average number of Pupils per teacher based on average number belonging.			
	High	Gram.	Primary	Kindg't	Total	High	Principals who do not teach classes.			Sex		High	Gram.	Prim.	Total						
							Grammar	Primary	Kind	High	Gram-mar					Special	Male	Female			
Bay.....	9	87	358		445		3	7					1	9	10		29	51	44.5		
Central High.....	16	452			452	17				1			6	12	18	27			27.0		
Clawson.....	9	39	350		389		1	8			1		1	10	10		39	44	43.0		
Cole.....	19	244	534		778		7	12			1		1	19	20		35	45	41.0		
Durant.....	19	341	533		874		8	11			1		1	19	20		43	48	40.7		
Franklin.....	16	49	219	333	601	2	7	7			1		1	16	17	25	31	47	37.6		
Garfield.....	15	90	444		534		4	11			1		1	16	16		22	40	35.6		
Grant.....	9	50	271		321		2	6						8	8		25	45	40.1		
Grove Street.....	4		131	39	170			3	1					4	4			42	42.5		
Harrison.....	8		301		301			7						7	7			43	43.0		
High.....	36	540			540	18					1		7	12	19	30			30.0		
Lafayette.....	15	123	605		728		4	12					1	16	17		31	50	45.0		
Lincoln.....	18	388	404		792		9	8			1		1	17	18		43	50	46.6		
Peralta.....	4	27	120		147		2	3					1	3	4		27	40	37.0		
Piedmont.....	5	43	144		187		1	3					1	4	5		22	48	37.4		
Prescott.....	20	128	590		718		5	13					1	18	19		26	45	39.9		
Sweet.....	9	58	254		312		2	6			1		1	8	8		29	42	39.0		
Temescal.....	8	36	260		296		2	6						7	8		18	43	37.0		
Tompkins.....	12	60	318		378		3	7			1		1	11	11		20	45	37.8		
Evening.....	10	158			158		5						2	3	5		31		31.6		
Special.....													6	3	3						
Total.....	261	1041	2091	5950	39 9121	37	65	130	1	2	9	6	28	222	250	28	32	46	39.1		

[illegible]



# HIGH SCHOOL FUND EXPENSE 1900-1901

	High School	Central	Observa- tory	Franklin	Evening	TOTAL
Apparatus .....	\$ 56 76					\$ 81 76
Books—Library .....		124 30	25 00			149 80
—Indigent Pupils .....		5 26	25 50			5 26
Carpet .....			173 62			173 62
Electricity .....	39 96					39 96
Expense Graduating Class .....	35 00	18 75				53 75
Fuel .....	489 99	187 70				677 69
Furniture .....			8 80			8 80
Gas and Electricity .....	40 30		135 00			175 30
Glass and Hardware .....	11 57	13 95	1 71			27 23
Laboratory Supplies—Chemical .....	112 05	56 22				168 27
—Biological .....	30 70					30 70
—Physical .....	68 85					68 85
Labor .....			9 00			9 00
Laundry .....	73 06	27 40				100 46
Paints, Oil, etc. ....	1 56	24 17				25 73
Postage .....	22 86	3 50	5 00			31 36
Printing .....	70 91	5 00				75 91
Repairs of Buildings .....	45 26	6 25				51 51
" Heaters .....		43 57				43 57
" Machinery .....		10 00				10 00
Salaries—Teaching and Supervising .....	30,027 28	21,955 25	1,200 00	2,312 28	578 57	56,073 38
—Janitors and Gardener .....	1,980 00	1,200 00	180 00			3,360 00
Scavenger .....	30 00	24 00				54 00
Stationery and School Supplies .....	79 11	596 58	27 55			703 24
Janitor's Supplies .....	64 83	8 54				73 37
Water .....	177 13	80 35				257 48
Tuition Returned .....	18 25					18 25
Telephone Service .....	30 65	24 00				54 65
Manual Training Dept.—Shop, Power .....		187 94				187 94
" " Tools, etc. ....		49 40				49 40
" " Supplies .....		340 00				340 00
Cooking Dept.—Gas .....		41 90				41 90
" " —Supplies .....		23 35				23 35
Sewing Supplies .....		94 14				94 14
	\$ 12,506 08	\$ 25,151 52	\$ 1,701 18	\$ 2,312 28	\$ 578 57	\$ 62,320 61

## COMPARATIVE STATISTICS.

	1897-8	1898-9	1899-00	1900-01
Total No. of pupils enrolled in all of the schools.....	12,263	11,888	11,976	12,849
Total No. of pupils enrolled in Grammar and Primary schools, exclusive of Evening schools.....	10,690	10,672	10,692	10,040
Total No. of pupils enrolled in Evening schools.....	785	503	578	593
Total No. of pupils enrolled in High School.....	657	584	585	615
Total No. of High School pupils enrolled in Central and Franklin schools.....	131	129	128	544
Average No. belonging in all of the schools, including Evening School.....	9,066	8,865	8,992	9,274
Average No. belonging in Grammar and Primary schools, exclusive of Evening schools.....	8,157	8,143	8,235	7,924
Average No. belonging in Evening schools.....	227	140	153	158
Average No. belonging in High School.....	571	473	506	540
Average No. High School pupils belonging in Central and Franklin schools.....	109	109	97	501
Average daily attendance in all of the schools.....	8,588	8,370	8,512	8,754
Average daily attendance in Grammar and Primary schools, exclusive of Evening schools.....	7,751	7,684	7,812	7,489
Average daily attendance in Evening schools.....	188	115	124	130
Average daily attendance in High School.....	543	468	485	518
Average daily attendance of High School pupils in Central and Franklin schools.....	105	103	91	490
Whole No. teachers employed in Department.....	246	239	241	250
Whole No. teachers employed in Grammar schools, including Evening schools.....	216	214	216	211
Whole No. teachers employed in High School.....	22	19	19	19
Whole No. teachers employed in Central, High School and Franklin.....	5	5	6	20
Average cost per pupil, based on average daily attendance.				
High School (proper).....	70.69	70.70	70.60	64.68
High School classes in Central School.....	51.70	61.00	79.88	56.77
Grammar and Primary.....	30.40	31.17	29.81	30.85
Evening Classes.....	38.77	32.50	27.15	25.52

